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Inspection Source Test Manual for Solvent Metal Cleaning (Degreasers)

Engineering-Science, Inc, Durham, NC

Prepared for

**Environmental Protection Agency, Washington, DC Div of Stationary Source
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INSPECTION SOURCE TEST MANUAL

FOR

SOLVENT METAL CLEANING

(DEGREASERS)

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CONVERSION FACTORS

1 KPa	=	7.5 mm Hg (at 100°F)	=	7.5 Torr
	=	0.15 psi (at 100°F)		
	=	1.03 bars		
1 m ³	=	3.785 x 10 ⁻³ gallons		
	=	1.337 x 10 ⁻¹ ft ³		
1 m	=	3.281 ft		
1 cm	=	3.937 x 10 ⁻¹ in		
1 in Hg	=	13.60 in H ₂ O		
1 liter	=	2.642 x 10 ⁻¹ gallons		
1 ml	=	2.642 x 10 ⁻⁴ gallons		
1 μl	=	10 ⁻⁶ liter		
1 mg	=	10 ⁻⁶ gram		
°K	=	°C + 273		

LIST OF ABBREVIATIONS

ASTM - American Society for Testing and Materials
Btu - British thermal unit
cfm - Cubic feet per minute
cm - Centimeters
°C - Degrees centigrade
CTG - Control Technology Guideline
dm - decimeter
EPA - Environmental Protection Agency
Ft - Feet
°F - Degrees fahrenheit
gal - Gallons
GC - Gas chromatography
Hg - Mercury
in - Inches
kPa - Kilograms per square centimeter (absolute pressure)
m - Meter
min - Minutes
mm - Millimeter
OSHA - Occupational Safety and Health Administration
ppm - Parts per million by volume
psi - Pounds per square inch
RACT - Reasonably available control technology
SIP - State Implementation Plan
TLV - Threshold limit value in ppm
VOC - Volatile organic compound

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CHAPTER 1

INTRODUCTION

1.1 SCOPE AND OBJECTIVE OF MANUAL

This document was prepared to assist U.S. Environmental Protection Agency Regional Offices and state/local air quality control agencies in implementing Reasonably Available Control Technology (RACT)¹ for volatile organic compound (VOC) emissions from solvent metal cleaning processes (more commonly referred to as degreasers). Specifically, this manual provides guidance in performing source inspections and compliance tests.

There are three basic types of solvent metal cleaning equipment; manual cold cleaners, open top vapor degreasers, and conveyorized degreasers. Chapters 2 through 4 discuss these operations, respectively. Each chapter contains a description of the process, identification of the emission points and the parameters that effect emissions, emission control methods, and a suggested inspection procedure. For those degreasers equipped with carbon adsorption control devices, it is necessary to perform emissions tests. Chapter 5 contains EPA's draft procedure for testing solvent emissions and also contains suggestions for performing screening tests and material balances.

Additional topics in this introductory chapter include EPA's policy regarding the implementation of RACT, identification of the solvents most commonly used in degreasers, a listing of field equipment needed for inspecting degreasers, and a discussion of the safety aspects of inspecting degreasers.

Chapters and sections of this document have been arranged in a format that permits easy and convenient replacement of material as information reflecting more accurate and refined inspection and testing procedures are developed. To speed dissemination of information, chapters or sections that contain new procedures will be issued separate from the parent report whenever they are revised. To facilitate the addition of future materials, the punched, loose-leaf format was selected. This approach permits the document to be placed in a three-ring binder or to be secured by rings, rivets, or other fasteners; future supplements or revisions can then be easily inserted.

¹For solvent metal cleaning operations, RACT is defined in the EPA Document "Control of Volatile Organic Emissions from Solvent Metal Cleaning" (EPA 450/2-77-022). This series of publications is also referred to as the Control Technology Guideline (CTG) documents.

1.2 EPA's POLICY ON RACT REGULATIONS FOR DEGREASERS

EPA's guidelines for RACT as applied to degreasers are contained in Appendix B to this manual. Separate guidelines were issued for cold cleaners, open top vapor degreasers, and conveyORIZED degreasers. Each guideline is divided into two levels of control. Control System A consists of operating practices and simple, inexpensive control equipment. Control System B consists of System A plus additional requirements to improve the effectiveness of control.

1.2.1 Application of Control Systems A and B

An approvable State Implementation Plan (SIP) must require the application of Control System B throughout urban nonattainment areas (>200,000 population) seeking an extension and to all facilities emitting VOC's in excess of 100 tons per year in other nonattainment areas. Facilities emitting 100 tons per year or less of VOC's in other nonattainment areas must apply Control System A as a minimum. However, EPA encourages states to control all degreasers in nonattainment areas to the Control System B level.

1.2.2 EPA's Policy on Exemptions

The CTG recommends two exemptions for solvent metal cleaning processes. First, conveyORIZED degreasers with an air/vapor interface of less than 2.0 square meters should be exempted from the requirement for a major control device. Requirements for controlling these smaller units would not be cost effective and would tend to move the small conveyORIZED degreaser users to open top vapor degreasers which emit more solvent per unit of work. Second, open top vapor degreasers with an open area of less than 1.0 square meter of open area should be exempt from the application of refrigerated chillers and carbon adsorbers since these controls would not be cost effective. These two exemptions are the only ones EPA will approve in urban nonattainment areas. Blanket exemptions such as a 3 pound per day cutoff or exemptions for cold cleaners will not be approved.

In rural nonattainment areas EPA will approve exemptions for sources emitting less than 100 tons per year of VOC's. This would allow a blanket exemption for cold cleaners since a typical cold cleaner emits approximately 0.3 tons per year. However, SIP's will not be approved that exempt all open top vapor degreasers and conveyORIZED degreasers that individually emit

less than 100 tons per year in rural nonattainment areas because large scale users may have over 100 separate degreasing operations at one plant location. If a State chooses to exempt open top or conveyORIZED degreasing operations in rural nonattainment areas, the limitation should be 100 tons or less on a facility-wide basis based on annual solvent purchase records. Further, any exemption which distinguishes between open top vapor degreasers and conveyORIZED degreasers will not be approved because of the potential of switching between equipment types. Although conveyORIZED degreasers are larger emitters, they emit significantly less solvent than do open top vapor degreasers for an equivalent workload. Thus, it would not be advantageous to encourage degreaser operators to choose open top vapor degreasers in order to avoid regulations on conveyORIZED degreasers.

1.3 DEGREASING SOLVENTS

Degreasing solvents are organic chemicals derived principally from petroleum. They commonly include (i) petroleum distillates such as Stoddard, kerosene, heptane and cyclohexane, (ii) halogenated hydrocarbons such as methylene chloride, perchloroethylene, 1,1,1-trichloroethane, trichloroethylene and trichlorotrifluoroethane (FC-113), (iv) oxygenated organics such as acetone, methyl ethyl ketone, isopropyl alcohol and ethers, and (v) aromatics such as toluene, turpentine and xylene. Table 1-1 summarizes some of the important properties of common metal cleaning solvents.

Selection of a solvent for a particular application depends on the type of cleaning to be done (cold or vapor), the nature of the grease and other soil to be removed, and the level of cleanliness required. The purpose of the solvent is to dissolve oils, grease, waxes, tars, and in some cases, water. When these materials have been removed from the work, insoluble material such as sand, metal chips, buffing abrasives and so forth are flushed away at the same time. Consideration must be given to nonmetallic portions of the work to be cleaned. For example plastic may be dissolved or otherwise deteriorated by certain solvents. Other materials may not be able to stand the heat necessary to boil high boiling solvents in vapor degreasers.

Halogenated hydrocarbons are used universally in vapor degreasers for two reasons. A very important consideration in solvent selection is its flammability especially if the solvent must be heated to create a vapor zone. The halogenated hydrocarbons used commonly in vapor degreasers are nonflammable. Second, the vapors of halogenated hydrocarbons are approximately four times more dense than air. This property enhances the stability of the solvent vapor zone and thus reduces diffusion and convection losses. Petroleum solvents are among the most widely used in cold cleaners, especially in maintenance cleaners. If petroleum solvents are not adequate for a particular cleaning application, the operator may turn to any of the various alcohols, ketones, aromatics or halogenated hydrocarbons that are capable of doing the job.

TABLE 1-1

COMMON METAL CLEANING SOLVENTS****

Type of Solvent/ Solvent	Solvency for Metal Working Solids	TLV (ppm)	Flash Point	Evaporation Rate**	Water Solubility (% wt.)	Boiling Point (Range)	Pounds Per Gal.	Price Per Gal.
Alcohols								
Ethanol (95%)	poor	1000*	60°F	24.7	∞	165-176°F	6.76	\$ 1.59
Isopropanol	poor	400*	55°F	19	∞	179-181°F	6.55	\$ 1.26
Methanol	poor	200*	58°F	45	∞	147-149°F	6.60	\$ 1.11
Aliphatic Hydrocarbons								
Heptane	good	500*	<20°F	26	<0.1	201-207°F	5.79	\$ 0.86
Kerosene	good	500	149°F	0.63	<0.1	354-525°F	6.74	\$ 0.66
Stoddard	good	200	105°F	2.2	<0.1	313-380°F	6.38	\$ 0.62
Mineral Spirits 66	good	200	107°F	1.5	<0.1	318-382°F	6.40	\$ 0.62
Aromatic Hydrocarbons								
Benzene***	good	10*	10°F	132	<0.1	176-177°F	7.36	--
SC 150	good	200	151°F	0.48	<0.1	370-410°F	7.42	\$ 1.06
Toluene	good	200*	45°F	17	<0.1	230-232°F	7.26	\$ 0.90
Turpentine	good	100*	91°F	2.9	<0.1	314-327°F	7.17	\$ 2.40
Xylene	good	100*	81°F	4.7	<0.1	281-284°F	7.23	\$ 0.96
Chlorinated Solvents								
Carbon Tetrachloride***	excellent	10*	none	111	<0.1	170-172°F	13.22	\$ 3.70
Methylene Chloride	excellent	500*	none	363	0.2	104-105.5°F	10.98	\$ 2.83
Perchloroethylene	excellent	100*	none	16	<0.1	250-254°F	13.47	\$ 3.33
1,1,1-Trichloroethane	excellent	350*	none	103	<0.1	165-194°F	10.97	\$ 2.78
Trichloroethylene	excellent	100*	none	62.4	<0.1	188-190°F	12.14	\$ 3.13
Fluorinated Solvents								
Trichlorotrifluoro- ethane (FC-113)	good	1000*	none	439	<0.1	117°F	13.16	\$ 7.84
Ketones								
Acetone	good	1000*	<0°F	122	∞	132-134°F	6.59	\$ 1.45
Methyl ethyl ketone	good	200*	28°F	45	27	174-176°F	6.71	\$ 1.74

*Federal Register, June 27, 1974, Vol. 39, No. 125.

**Evaporation Rate determined by weight loss of 50 ml in a 125 ml beaker on an analytical balance. (ml/dm²/min) (Dow Chemical Co., method).

***Not recommended or sold for metal cleaning (formerly standards in industry).

****Primary source from The Solvents and Chemicals Companies "Physical Properties of Common Organic Solvents" and Price List (July 1, 1975).

Evaporative losses in cold cleaners increase as the volatility of the solvent increases. In addition, cold cleaning solvents are sometimes heated or agitated to improve cleaning, further increasing evaporative losses. EPA has included more stringent control requirements under Control System B for the more volatile solvents. Figures 1-1 and 1-2 provide the vapor pressures of a number of solvents as a function of temperature.

FIGURE 1-1

SOLVENT VAPOR PRESSURE VS. TEMPERATURE

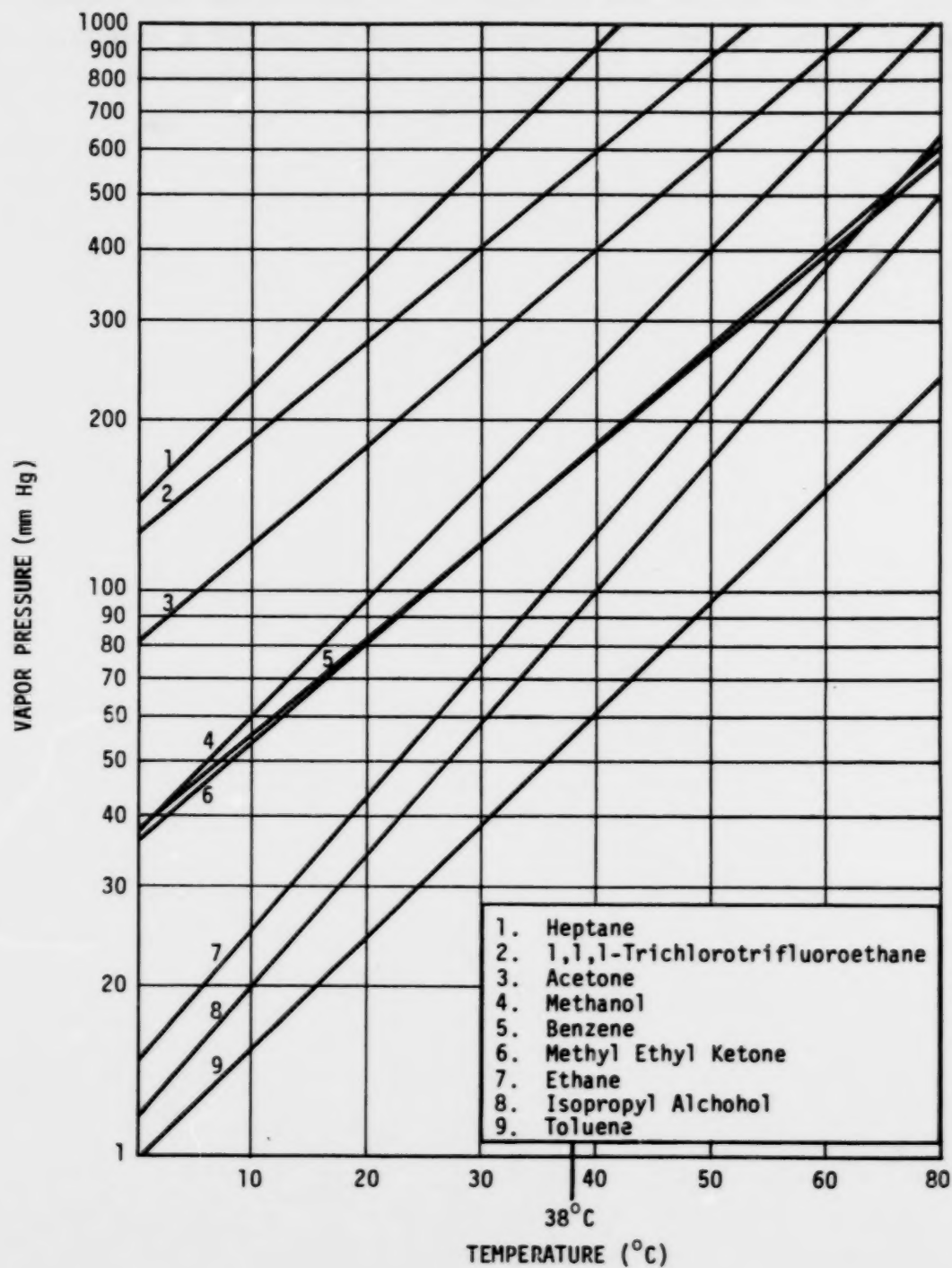
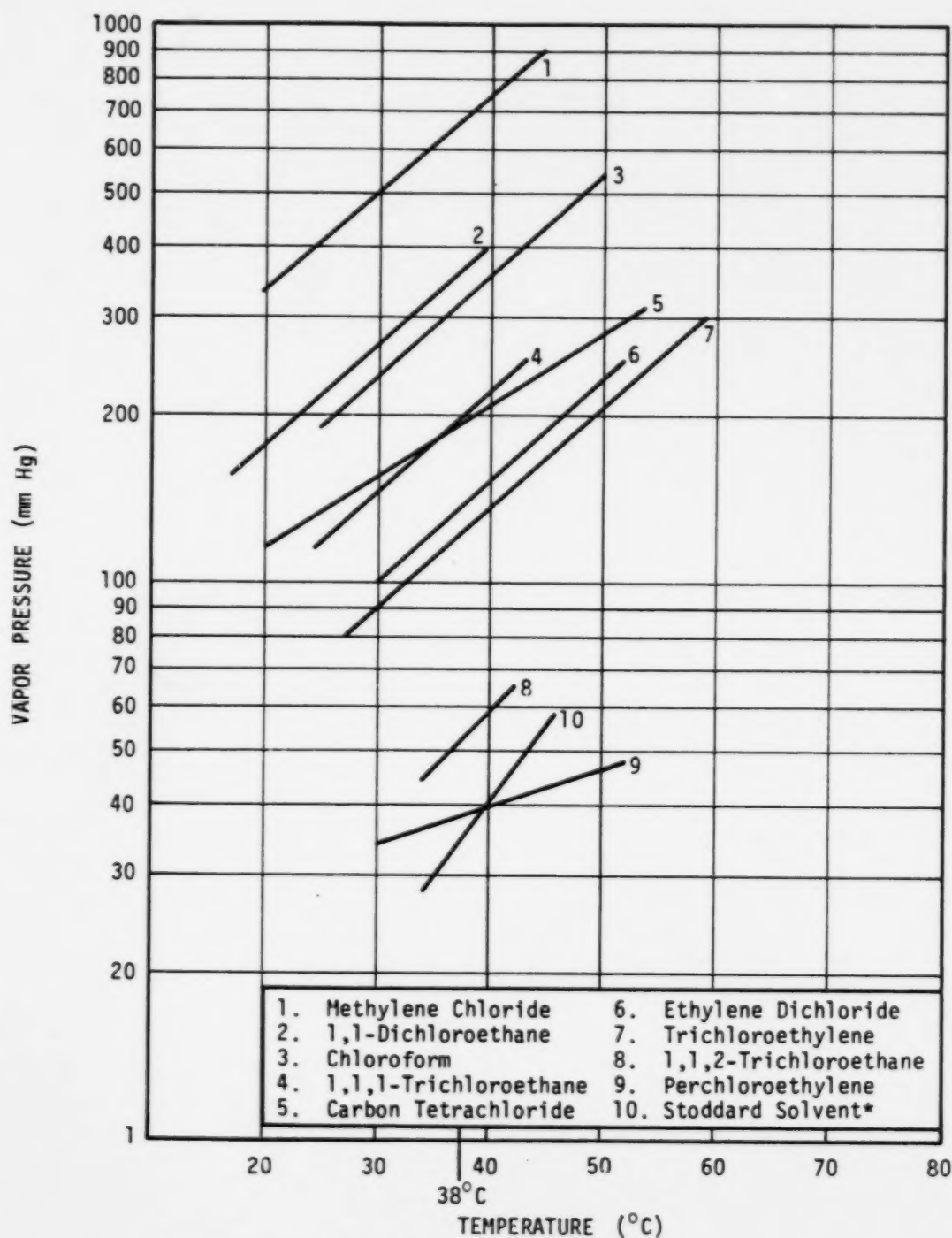


FIGURE 1-2

VAPOR PRESSURE VS TEMPERATURE FOR CHLORINATED SOLVENTS



*Stoddard is not a chlorinated solvent

1.4 INSPECTION EQUIPMENT

The inspector should arrive at the plant with all the necessary personal safety and testing equipment. The requisite personal safety equipment will depend on the nature of the activities at the plant; the inspector should be prepared with the minimal routine items, that is, a hard hat, steel-toed shoes and safety glasses.

Field equipment specific to degreaser inspections should include the following:

- o Tape measure for measuring degreaser area and stack dimensions
- o Thermometer (dial type) for measuring condensor coil water temperature
- o Stop watch for timing operational procedures
- o Small plastic bottle for collecting sample of condensor coil water
- o Swinging vane velocity meter (velometer) for measuring exhaust stack velocity
- o Refer to Chapter 5 for a list of stack testing equipment

A thorough discussion of inspection equipment, general field enforcement activities and inspection techniques may be found in "Field Operations and Enforcement Manual for Air Pollution Control, Volume I: Organization and Basic Procedures". EPA Publication Number APTD-1100 (NTIS Publication No. PB 213008, \$10.75).

1.5 SAFETY CONSIDERATIONS

All of the solvents used in degreasers have toxic characteristics if inhaled at sufficient concentration levels (see Table 1-1). It should never be necessary for the air pollution inspector to enter a drained degreaser sump. Several safety precautions are necessary (ventilation, safety harnesses, respirators, tests for flammability of vapors, etc.) that are best left to the operators that are properly trained in the safety requirements.

Most solvents are flammable, and even those that are not may develop flammable or even explosive mixtures in the sump, depending on the nature of the contaminants. Do not smoke near a degreaser.

Transfer of solvent into the degreaser or into waste storage containers can cause splashing. The inspector should stand clear of these operations.

Heat is another potential hazard. Vapor degreaser walls may be hot enough to burn hands. Never put hands below the vapor level inside a vapor degreaser. These vapors can exceed 200°F and are extremely powerful solvents.

CHAPTER 2

COLD CLEANERS

2.1 PROCESS DESCRIPTION

2.1.1 Unit Operation

Manually operated cold cleaners provide solvent degreasing for low volume workloads of small, variably shaped automotive and general plant maintenance parts, and for fabricated metal products. The basic steps involved in degreasing with a cold cleaner include soaking with solvent in the dip tank, and drying the work of solvent after cleaning.

The solvent dissolves the dirt/grease on the part to be cleaned as it is immersed. The part is usually lowered into the solvent bath in a metal basket. The cleaning action is often enhanced by agitation of the solvent and by spraying solvent on the part. After cleaning the part is dried by allowing evaporation and drainage of the solvent on drying racks which are located inside the cleaner or on external racks which route the drainage back into the cleaner.

Many cold cleaners which are equipped with sprayers or pump agitation utilize filters in the pump piping system to remove sludge and dirt thus extending the useful life of the solvent.

2.1.2 Types of Cold Cleaner Degreasers

Cold cleaners can be generally classified as maintenance and manufacturing degreasers. Maintenance cold cleaners are by far more common and are used for automotive and plant maintenance cleaning. Maintenance cold cleaners are usually smaller, simpler and less expensive than manufacturing cleaners. A typical size of maintenance cold cleaners is approximately 0.4 m^2 (4 ft^2) of opening and 0.1 m^3 (30 gallon) solvent capacity.

Manufacturing cold cleaners are employed in applications where a larger volume workload, a higher degree of cleaning and larger parts to be cleaned dictate the use of larger more specialized degreasers. Manufacturing cold cleaners are usually found in metal fabrication facilities. The larger size, greater workload and higher solvency needed to achieve the degree of cleaning required of manufacturing cold cleaners result in more solvent emissions than is usually released by maintenance cold cleaners.

The variety of specific applications for cold cleaners offers a method for more accurately classifying cold cleaners by agitation technique and tank design.

The two basic designs are the dip tank and the spray sink, although many cold cleaners employ both cleaning methods. Dip tank cleaners (Figure 2-1) allow for more thorough cleaning by providing for soaking dirty parts in the liquid solvent bath. The spray sink (Figure 2-2) is simple, inexpensive and used when a relatively low degree of cleanliness is required. As can be seen from Figure 2-2, the liquid solvent tank is not accessible for soaking parts; however, solvent losses due to bath evaporation are insignificant with this arrangement.

2.1.3 Operation of Degreaser Components

Agitation of the liquid solvent in dip tanks further improves cleaning efficiency and can be provided by pumping, compressed air, vertical motion or ultrasonic vibration. Pump agitation rapidly circulates solvent through the tank. Compressed air is dispersed from the bottom of the tank in air agitation. The rising bubbles scrub the surface of the work. Vertically agitated cold cleaners vibrate the dirty parts up and down in the tank with a motor driven, cam actuated device usually operated at 60-70 cycles per minute. Ultrasonic agitation vibrates the solvent with high frequency sound waves. This vibration causes cavitation, the implosion of bubbles of vaporized solvent on the surface of the parts, which breaks down the dirt film. To optimize cavitation, the solvent is usually heated to a specific temperature.

Other degreaser components that are discussed in this chapter include the cover, spray pump and hose, internal and external drain boards and the parts basket.

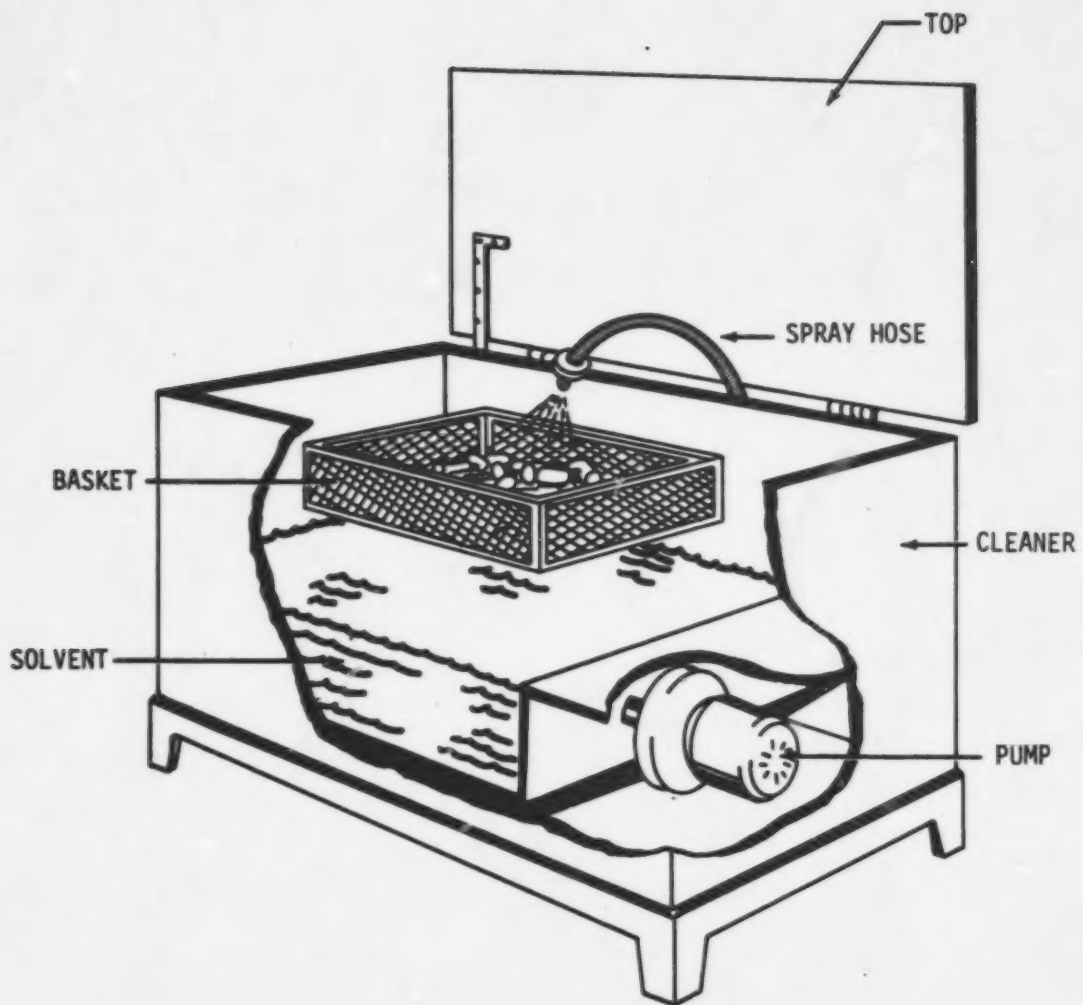
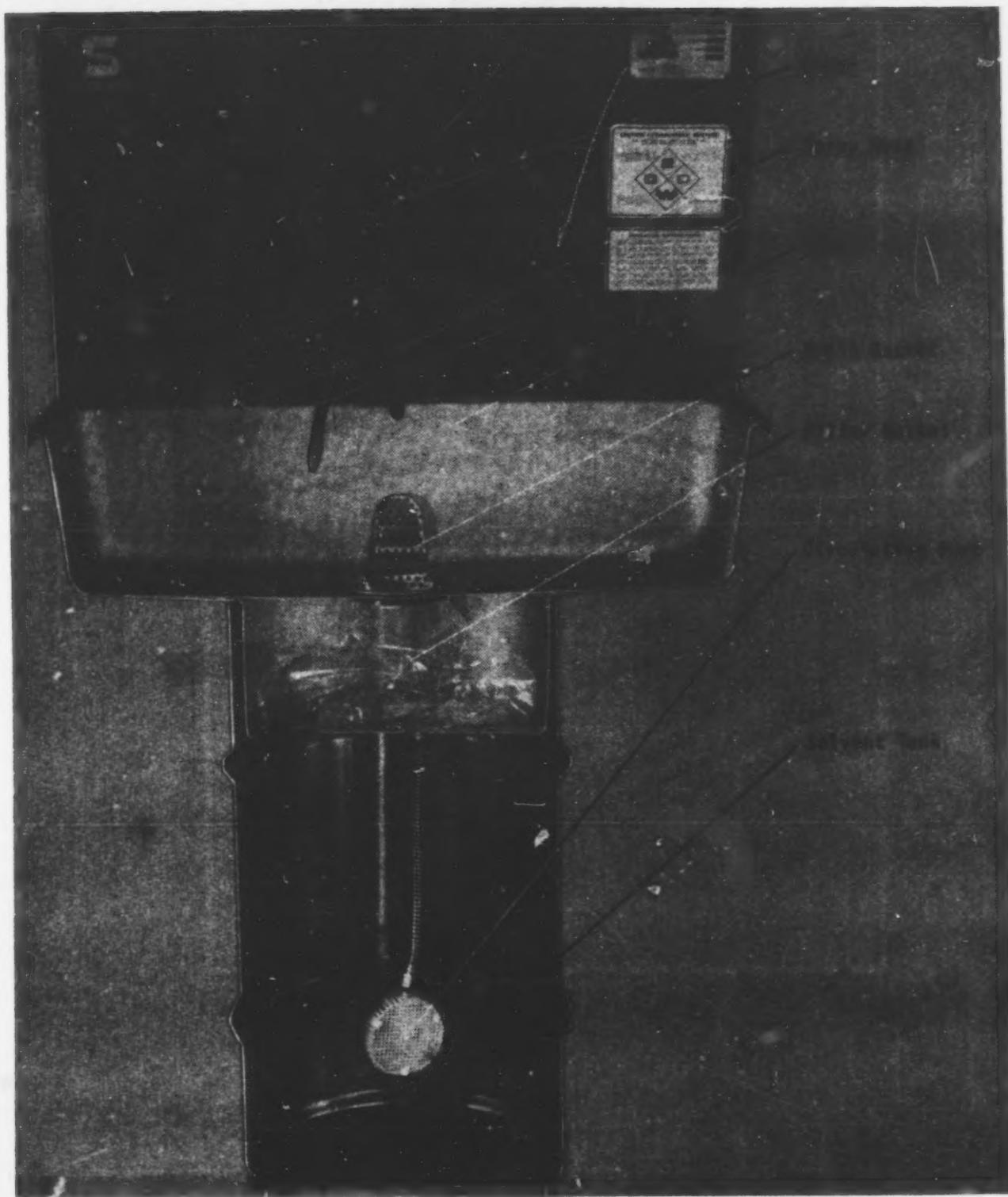


Figure 2-1. Cold Cleaner

Figure 2-2
SPRAY SINK

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best available copy.



(Safety-Kleen, New Berlin, Wisconsin)

2.2 ATMOSPHERIC EMISSIONS

2.2.1 Emission Points

Solvent evaporation is the basic emission mechanism for cold cleaners and the emission rates vary with size, frequency of use, and manner of their operation. Based on national consumption data, cold cleaners each emit an average of 0.3 metric tons of solvent vapor per year. Maintenance cold cleaners emit an average of 0.25 metric tons per year and manufacturing cold cleaners emit an average of 0.5 metric tons per year. Emissions from manufacturing cleaners are larger primarily because their units are used more steadily in the course of a work day than maintenance cleaners.

There are several means by which organic solvent vapors can be emitted to the atmosphere from a cold cleaner. These are illustrated in Figure 2-3. Cold cleaners are very rarely hooded or vented to the outside. Thus, an obvious emission point is the direct evaporation of solvent from the tank to the atmosphere (Location 1). Carry out emissions (Location 2) result from liquid solvent that is physically carried out of the degreaser on the cleaned parts and subsequently evaporates. Mechanical agitation of the solvent bath (Location 3) increases evaporative losses. Turbulence from spraying (Location 4) increases emissions as does overspraying (spraying outside the tank), and excessive spray velocity. Finally, the emissions from the disposal of waste solvent (Location 5) can vary significantly, depending on the techniques employed.

2.2.2 Parameters Affecting Rate of VOC Emissions

Bath evaporation occurs whenever the degreaser's hood is open but is increased by air movement such as drafts or ventilation and is directly related to the evaporation rate of the solvent used. The solvents most commonly used by cold cleaners are Stoddard solvents, safety solvents (blends of chlorinated hydrocarbons and petroleum solvents), ketones and fluorinated solvents.

Bath evaporation can be minimized during operation when adequate freeboard height (distance from solvent level to top of the cold cleaner) is employed. Freeboard height requirements are often expressed as freeboard ratio, which is the ratio of freeboard height to the width of the degreaser.

Bath evaporation emissions can be further reduced by keeping the degreaser cover closed during degreasing operations except when parts are removed from or added to the degreaser. Various types of covers are available. Sliding plastic covers which roll up on a rotating shaft at one end of the degreaser when not in use are the most simple and easy to use. Some large degreaser covers use counterweights. Electrically or pneumatically powered covers are also used. Guillotine covers are another easily operated type found on many degreasers. Generally, the amount of effort required will dictate the frequency of use of the cover and therefore dictate the amount of bath evaporation. Hatch type covers such as the one shown in Figure 2-3 usually have a fusible link support arm so that they will slam shut in the event that a fire breaks out. Local fire and safety codes often require such devices.

Air flow into the tank also influences solvent evaporation. The degreaser should be located to minimize evaporative losses due to work fans and ventilation ducts. Partitions, curtains or baffles help create a still air zone around the degreaser and can reduce bath evaporation emissions.

Control devices are required for cold cleaners with heated ($>50^{\circ}\text{C}$) or highly volatile (volatility >4.3 Kpa measured at 38°C) solvent. (The term "cold cleaner" applies even if the solvent is heated, as long as the objective is not to create a vapor zone.) The control devices which comply with the RACT guidelines are refrigerated chillers, freeboard ratios >0.7 , carbon adsorption and water blankets. If properly applied, maintained and operated, these control devices can significantly reduce solvent emissions.

Refrigerated chillers are condensing coils located peripherally along the freeboard, which condense the solvent vapor before escaping from the degreaser. Carbon adsorption is a device which reclaims solvent from the air/vapor mixture escaping the cleaner. These are rarely used on cold cleaners.

A water blanket is a layer of water in the dip tank on top of the solvent which provides a vapor barrier between the solvent and the atmosphere. The solvent must be heavier than and insoluble in water.

Carry-out emissions occur when wet parts are removed from the degreaser and are influenced by: drying procedure, location and type of drying racks, size of the parts being cleaned, and the volume of the workload.

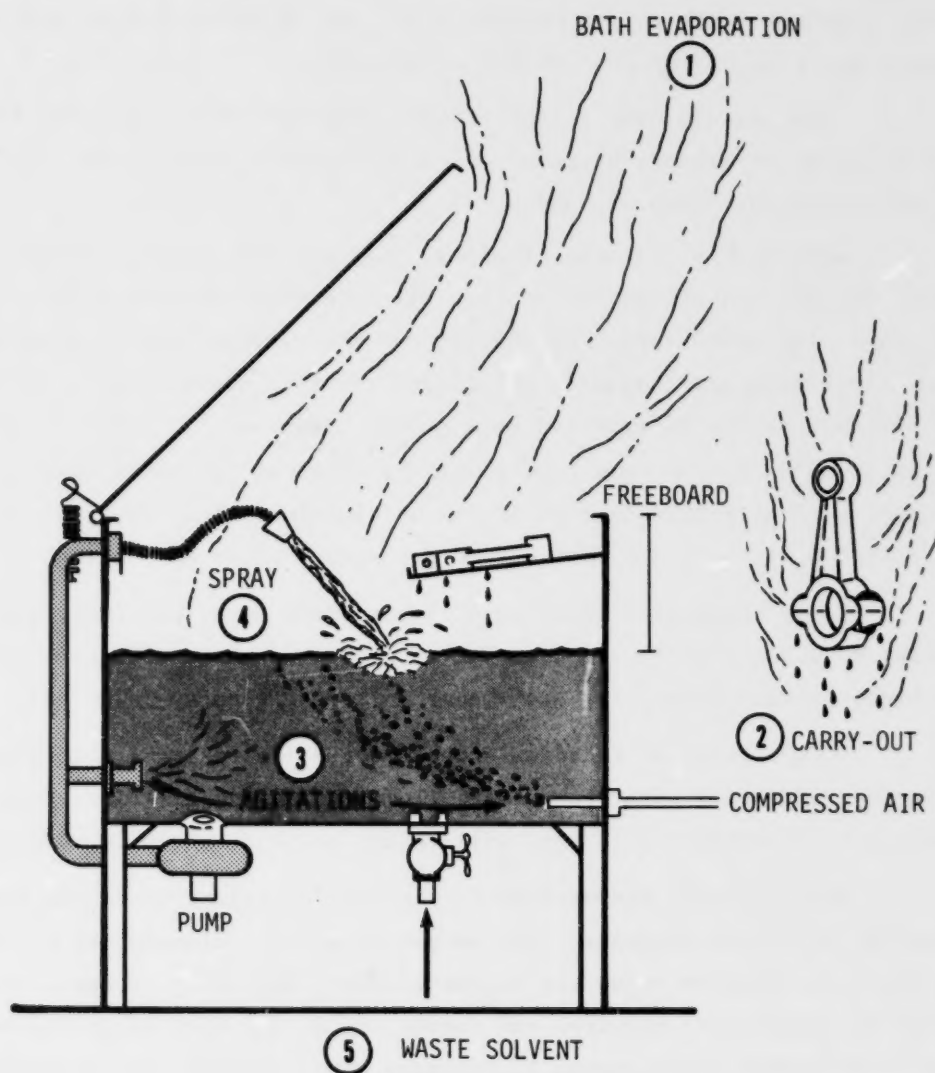


Figure 2-3. Cold Cleaner Emission Points

Drainage of any solvent entrained in crevices or depressions in the parts prior to moving them to external drying racks, and closing the hood during drying if internal racks are used, minimizes carry-out emissions. If external racks are employed, drains which return the carried-out solvent to the degreaser tank reduce solvent loss. As recommended from ASTM D-26, cleaned parts should be drained for 15 seconds.

The surface area of the parts workload affects carry-out since the mass-transfer of solvent by evaporation is directly proportional to the amount of solvent-laden surface area.

Agitation increases emissions. Agitation intensity, amount of heat input, if any, and solvent volatility all affect VOC emissions from cold cleaners. Proper operating procedures can minimize emission during agitation. Emissions are insignificant if the cover is closed during agitation and the bath should be agitated only during cleaning. If air or pump agitation is used, the flow rate should be adjusted to the minimum amount required to achieve the desired degree of cleaning. Air flow rate should not exceed 0.01 to 0.03 m³ per minute per square meter of opening.

Evaporation from spraying will vary with spray pressure, spray droplet size and distribution, amount of overspray which splashes from the sink, solvent volatility and amount of time the spray is in use.

Spray operating techniques can lower emissions. Care to eliminate overspray, adjusting spray to a solid fluid stream and limiting spray fluid pressure to a maximum of 10 psig will reduce solvent losses by evaporation.

Waste solvent evaporation is the single largest mechanism for solvent emissions from cold cleaning. The amount of solvent disposed by a single degreaser is dependent upon the degreaser size, frequency of operation, degree of cleanliness required and amount of oil and dirt to be removed. If a cold cleaner spray system is equipped with a filter, the frequency of disposal is reduced.

Leaks in spray lines and agitation pump discharge lines which are under pressure can cause significant solvent emissions. Pipe flanges, drain valves, corroded tanks (especially when using an acidic solvent or if water is present in the solvent) can also leak if not properly maintained.

Acceptable methods of disposal include recycling by distillation, proper incineration, distillation (recovery of solvent for re-use) and chemical landfilling if waste is enclosed in sealed containers and surrounded by impermeable soil.

Disposal by flushing solvent into sewers, spreading solvent for dust control and landfilling without proper containers or prevention of leaching all result in complete evaporative emissions of waste solvent to the atmosphere.

Solvent emissions are greatly influenced by the type of solvent. Obviously volatility and operating temperatures are significant parameters affecting emissions. Highly toxic solvents are more conscientiously controlled to protect workers and comply with OSHA regulations. Solvent costs often determine the care with which degreasers are operated. More expensive solvents are usually conserved by the same procedures which reduce emissions and are more likely to be recycled.

2.3 EMISSION CONTROL METHODS

The EPA Control Technology Guideline (CTG) document for solvent metal cleaning identifies a number of control strategies for reducing volatile organic emissions from cold cleaning degreaser operations. These form the basis of defining RACT for the cold cleaning degreasers and should therefore be the focal point of a field inspection. The CTG suggests two levels of control. (See Table 2-1). Level A could reduce cold cleaning emissions by 50% (+20%) and Level B may achieve a reduction of 53% (+20%). The range represents the limits of reduction for poor operating procedure (-20%) and good operating procedure (+20%). The estimated benefit from Level B only slightly exceeds that from Level A, assuming low volatility solvents. This is because the additional devices required in Level B generally control only bath evaporation which represents only 20% to 30% of the total emissions from an average cold cleaner. For cold cleaners using highly volatile solvents, bath evaporation may constitute 50% of the total emissions, and it is estimated that Level B would then achieve an emissions reduction of 69% (+20%) and a 55% (+20%) reduction for Level A.

The preceding discussion on the parameters affecting the rate of VOC emissions (Section 2.2.2) explicitly identifies the equipment and operating procedures necessary to implement the RACT control strategies except for the disposal of waste solvent. Dirt, grease, oil, metal chips and the like slowly build up in the liquid solvent over a period of time and eventually severely affects its ability as a cleaning agent. This usually occurs when the solvent contamination level reaches about 10 percent by volume. It is fairly common for the small operator to secure a service contract that provides for reclaiming the spent solvent. The contractor distills the spent solvent and returns it to users for a fee. One organization rents the cold cleaner and provides the solvent reclamation service as a package deal. Large operations that use scores of manufacturing cold cleaners sometimes operate stills on-site to reclaim the solvent. Distillation, proper landfilling, and incineration (which is not commonly used) will meet the RACT operating requirements ("not greater than 20 percent can evaporate into the atmosphere"). Disposal of the waste solvent (and still bottoms) at landfills may be subject to hazardous waste disposal regulations. EPA has proposed regulations governing the disposal of such material in the Federal Register at 43FR58946 (December 18, 1978).

TABLE 2-1
CONTROL SYSTEMS FOR COLD CLEANING

Control System A

Control Equipment

1. Cover
2. Facility for draining cleaned parts
3. Permanent, conspicuous label, summarizing the operating requirements

Operating Requirements:

1. Do not dispose of waste solvent or transfer it to another party, such that greater than 20 percent of the waste (by weight) can evaporate into the atmosphere.* Store waste solvent only in covered containers.
2. Close degreaser cover whenever not handling parts in the cleaner.
3. Drain cleaned parts for at least 15 seconds or until dripping ceases.

Control System B

Control Equipment:

1. Cover: Same as in System A, except if (a) solvent volatility is greater than 2 kPa (15 mm Hg or 0.3 psi) measured at 38°C (100°F),** (b) solvent is agitated, or (c) solvent is heated, then the cover must be designed so that it can be easily operated with one hand. (Covers for larger degreasers may require mechanical assistance, by spring loading, counterweighting or powered systems.)
2. Drainage facility: Same as in System A, except that if solvent volatility is greater than about 4.3 kPa (32 mm Hg or 0.6 psi) measured at 38°C (100°F), then the drainage facility must be internal, so that parts are enclosed under the cover while draining. The drainage facility may be external for applications where an internal type cannot fit into the cleaning system.
3. Label: Same as in System A
4. If used, the solvent spray must be a solid, fluid stream (not a fine, atomized or shower type spray) and at a pressure which does not cause excessive splashing.
5. Major control device for highly volatile solvents: If the solvent volatility is > 4.3 kPa (33 mm Hg or 0.6 psi) measured at 38°C (100°F), or if solvent is heated above 50°C (120°F), then one of the following control devices must be used:
 - a. Freeboard that gives a freeboard ratio*** ≥ 0.7
 - b. Water cover (solvent must be insoluble in and heavier than water)
 - c. Other systems of equivalent control, such as a refrigerated chiller or carbon adsorption.

Operating Requirements:

Same as in System A

*Water and solid waste regulations must also be complied with.

**Generally solvents consisting primarily of mineral spirits (Stoddard) have volatilities - 2 kPa.

***Freeboard ratio is defined as the freeboard height divided by the width of the degreaser.

2.3.1 Other Controls

Where work being degreased contains acid cutting oils or other acidic products, acid acceptance and PH determination should be made to ascertain the quality of the solvent.

Absorbent materials such as wood or fabric materials should not be degreased or used in basket construction.

The cold cleaner should be inspected for solvent leaks and repairs should be made as necessary.

2.4 INSPECTION PROCEDURES

This section will discuss two types of inspections: (1) field review and (2) office reviews. Source sampling, still another form of inspection, is only feasible for measuring the stack gases from carbon adsorption systems which are rarely used for cold cleaning degreasers.

Field inspections range from plant visits to thorough inspections that produce a complete data base for enforcement proceedings. Office reviews rely on the source to furnish the information. This approach may require less time and manpower but the resulting data base is generally less complete. Office reviews, however, provide a useful screening mechanism where the number of potential violators is large.

2.4.1 Field Inspections

After becoming familiar with the plant and its facilities the inspector should request that the appropriate company official provide information from company records that will allow the inspector to complete the worksheets shown in Figure 2-4. The data may also be available from permit applications. The worksheet divides the required data into two categories: operating requirements and control equipment. It also provides the RACT requirements for each category with suggested inspection procedures and guidelines. With such information, comparisons can be made with past conditions, and with operations at the time of the inspection.

Generally, the inspector would next request the company's assistance in conducting a full inspection of the facility in order to verify actual operating conditions. This inspection may take several hours depending on the number and types of degreasers.

All field data such as solvent temperature and type should be measured or observed first hand. Auxiliary degreaser components (sprayer, agitator, etc.), and waste solvent, recovery, disposal or storage facilities should be seen and verified. Operating procedures should be observed and noted. Degreasers should be inspected for condition of hoses, connections, drains and for leaks. The inspector should check for ventilation ducts, location of work fans and air flow baffles near the degreaser which may affect solvent evaporation rate. The inspection should include evaluation of those parameters which influence emissions as discussed earlier in this chapter.

FIGURE 2-4

EXAMPLE WORKSHEET FOR FIELD INSPECTION OF

COLD CLEANERS

1. BUSINESS LICENSE NAME OF CORPORATION, COMPANY, OR INDIVIDUAL OWNER OR GOVERNMENTAL AGENCY:		
2a. MAILING ADDRESS:		2b. PLANT ADDRESS WHERE THIS DEGREASER IS LOCATED:
3. SOURCE NO. (PERMIT NUMBER, WEDS ID, ETC.):		
4. NAME AND TITLE OF COMPANY REPRESENTATIVE:		
5. TELEPHONE NO.:		
6. NAME OF OFFICIAL CONDUCTING INSPECTION:		
7. DEGREASER		
MANUFACTURER: _____ MODEL NO. _____ SERIAL NO. _____		
INSIDE DIMENSIONS OF TANK (FT.): _____ WIDE X _____ LONG X _____ DEEP		
TYPE OF DEGREASER: SPRAY SINK ☐ DIP TANK ☐		
8. TITLE AND CODE NUMBERS OF DRAWINGS, SPECIFICATIONS, STANDARDS, CODES, PROCEDURES AND DOCUMENTS USED WITH THE INSPECTION _____		
9. TYPE OF SOLVENT IN USE (SPECIFIC NAME AND MANUFACTURER): _____		
INSPECTION OBSERVATIONS		
RACT REQUIREMENT	SUGGESTED INSPECTION PROCEDURE	FIELD OBSERVATION
<u>CONTROL EQUIPMENT</u>		
1. Cover	o Observe if a cover is installed and if it is closed when parts are not being handled in the degreaser.	
2. Cover must be easily operated with one hand if: - Solvent volatility >2 kPa (measured at 38°C) - Solvent is agitated - Solvent is heated	o Observe if cover can be operated with one hand. Observe if solvent is heated or agitated. If degreaser cover is large, check for mechanical assistance for operation. Determine the solvent type and its volatility. Vapor pressures for common solvents can be found in Chapter 1 of this manual.	
3. Drainage Facility	o Observe if drainage racks are provided. If drainage racks are external to the degreaser, observe if drainage is routed to the solvent bath.	
4. Internal drainage facility is required if: - Solvent volatility > 4.6 kPa (measured at 38°C)	o Observe if drainage racks are internal. Determine solvent volatility.	

FIGURE 2-4

(Continued)

FACT REQUIREMENT	SUGGESTED INSPECTION PROCEDURE	FIELD OBSERVATION
5. Solvent spray must be a solid fluid stream and at a pressure that does not cause splashing.	o Observe if spray forms a mist or shower type consistency. Check for splashing above degreaser freeboard	
6. Permanent conspicuous label summarizing operating requirements.	o Observe if label is clearly displayed, complete and permanently fastened to degreaser	
7. If solvent volatility >4.3 kPa measured at 38°C, or solvent temperature is > 50°C then one of the following control measures must be used. a. Freeboard Ratio ≥ 0.7 b. Water Cover c. Other systems of equivalent control such as chiller or carbon adsorption	- o Determine if requirement is applicable - o Measure solvent temperature (if heated) with thermometer - o Calculate from degreaser dimensions. Freeboard ratio = $\frac{\text{Freeboard}}{\text{Width}}$ - o Observe if the solvent is covered with water. - o Determine if appropriate device is installed and operational	
<u>OPERATING REQUIREMENTS</u>		
1. Do not dispose of waste solvent or transfer it to another party such that greater than 20% (by weight) can evaporate to the atmosphere. Store waste solvent only in covered containers.	- o Determine if source has inhouse reclamation facility (i.e. still) or a service contract with a solvent reclamation firm. - o Confirm that storage is done with covered containers. Note whether containers leak.	
2. Close degreaser cover whenever not handling parts in the cleaner.	o Observe the operation	
3. Drain parts for at least 15 seconds or until parts are dry.	o Observe this operation. Time if necessary, or determine if parts are dry when removed from drying rack.	

If the degreaser is not in use then only design data and records review can be performed during the field inspection. Maintenance degreasers are used intermittently and may not be operating during the inspections. Manufacturing cold cleaners are generally an integral part of a manufacturing process and normally will be operating. It is important to note that operating procedures (use of cover, drain and drying time, spray technique) can have a significant impact on solvent emissions regardless of equipment design.

The information gathered during the field inspection will be compared to the data given by the company official, and the total data base will be compared to the RACT requirements for design, operating and control requirements to determine if a violation exists. At that time, a reinspection date should be established if it is determined that the source is not in compliance.

Figures 2-5 and 2-6 are photographs of a maintenance cold cleaner of a design that would typically be encountered by an inspector. In Figure 2-5 the rectangular box in the corner of the tank contains the spray pump, the cylindrical housing contains pump filter. Figure 2-6 shows that this cleaner has been equipped with two spray hoses; the flexible metal hose is the original equipment, the garden hose and nozzle was retrofitted by the operator in order to increase the spray velocity. This arrangement potentially violates the RACT requirement that the solvent spray must be "...a solid, fluid stream (not a fine, atomized or shower type spray) and at a pressure that does not cause excessive splashing". Also, note the pan located underneath the drainage rack. Drippings from drying parts are accumulated on the pan, rather than returned to the tank. This increases the surface area of solvent, thus increasing evaporative losses.

2.4.2 Record Review

Determining compliance of cold cleaning degreasers through field inspections and monitoring is expensive and time consuming. It requires a great deal of manpower and tends to limit the number of sources that can be reviewed in a given year. The review of company-furnished records through questionnaires or letter requests may provide a viable alternative to field inspections and source monitoring activities for compliance determination. At minimum, this approach should be considered as a screening tool to identify candidate sources for comprehensive field inspections, thereby increasing the effectiveness of the available resources.

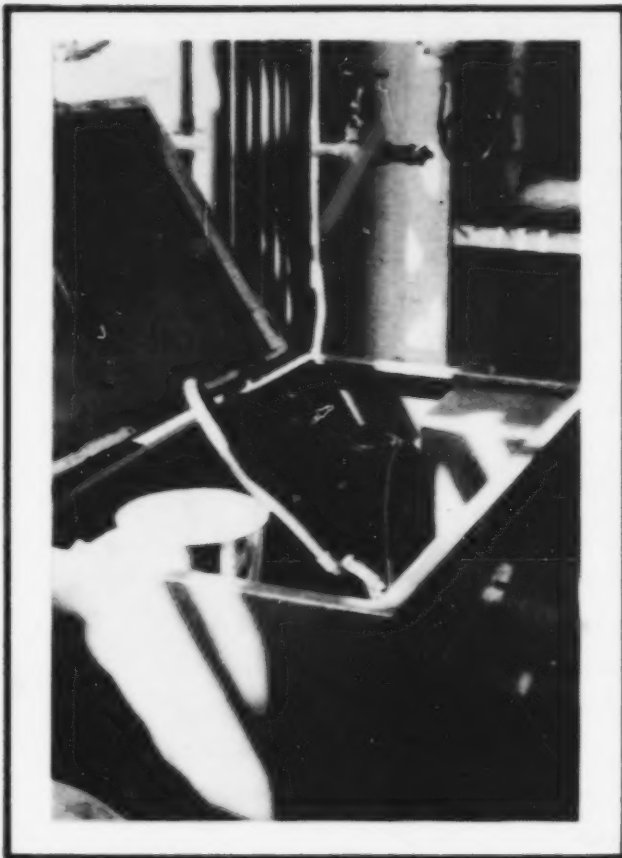


Figure 2-5
**MAINTENANCE
COLD
CLEANER**

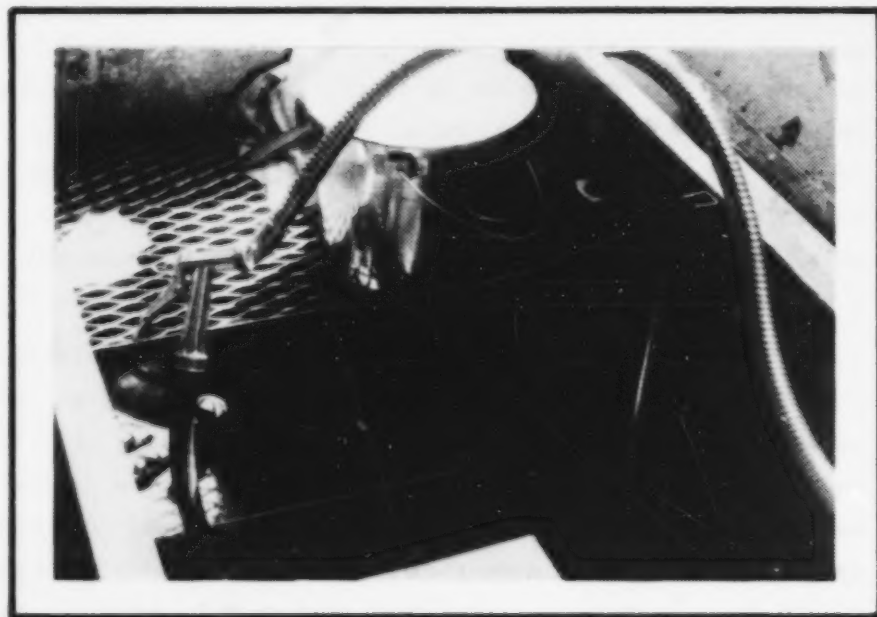


Figure 2-6
**DRAINAGE
RACK**

This discussion outlines several procedures which may be used when implementing a record review. Information will be required from the plant concerning the design, operation and maintenance of the equipment.

When screening sources for setting inspection priorities by office review of questionnaires, the estimated average emission rates of 0.25 metric tons per year for maintenance cold cleaners and 0.50 metric tons per year for manufacturing cold cleaners can be applied to individual degreasers to estimate the total cold cleaning solvent emissions for a specific source. Comparison of the total emissions for each source can aid in allocating manpower for inspections to achieve effective use of an enforcement agencies resources.

2.4.2.1 Review of Design, Operation, and Maintenance Data

The first requirement of this procedure is the development of standard questionnaires that can be sent out as part of a Section 114 request to the applicable sources. The type of information required is similar to what is identified on the inspection forms illustrated in Figure 2-4. It is important that the source understand what is being requested and that the request be realistic because the entire process of making compliance judgments using this procedure is highly dependent on the reliability of the information furnished.

An example questionnaire is provided as Figure 2-7 and should be used as a guide only. It is suggested that the agency develop its own form which would be specific to the program. For example, a screening program may only require key data, while a more extensive request is necessary if compliance determinations are to be attempted. Three types of data are suggested for review: design information, operational information, and maintenance records. The design data should be readily available, while operational and maintenance may require the source to create a special logging system in order to comply with the agency's request.

Design data should be compared to the RACT requirements and review should include such items as degreaser dimensions, solvent bath volume, solvent type, auxiliary components (agitation, spray, etc.) and type of cover and drainage facility. Operational information such as solvent makeup schedule (if any) and rate, disposal schedule and procedure, and frequency of degreaser operation should be reviewed. Maintenance records should report repair or replacement records and comment on the general condition of the equipment.

FIGURE 2-7

EXAMPLE QUESTIONNAIRE FOR OFFICE REVIEW

OF COLD CLEANING DEGREASERS

GENERAL	
1. BUSINESS LICENSE NAME OF CORPORATION, COMPANY, OR INDIVIDUAL OWNER OR GOVERNMENTAL AGENCY:	
2a. MAILING ADDRESS:	2b. PLANT ADDRESS WHERE THIS DEGREASER IS LOCATED:
3. SOURCE NO. (PERMIT NUMBER, NEDS ID, ETC.):	
4. NAME AND TITLE OF AUTHORIZED COMPANY REPRESENTATIVE FURNISHING DATA:	SIGNATURE:
5. TELEPHONE NO.:	
6. DEGREASER:	
MANUFACTURER: _____ MODEL NO. _____ SERIAL NO. _____ INSIDE DIMENSIONS OF TANK (FT): _____ WIDE X _____ LONG X _____ DEEP DIP TANK ☐ SPRAY SINK ☐	
7. TYPE OF SOLVENT IN USE (SPECIFIC NAME AND MANUFACTURER): _____	
8. EQUIPMENT DESIGN	
TANK COVER: YES ☐ NO ☐ DRAINAGE BOARD YES ☐ NO ☐ INTERNAL ☐ ACITATION: YES ☐ NO ☐ EXTERNAL ☐ PUMPED ☐ MECHANICAL ☐ AIR ☐ ULTRASONIC ☐ DRAINAGE RETURN (IF EXTERNAL) ☐ HEATED: YES ☐ NO ☐ SOLVENT SPRAY: YES ☐ NO ☐ IF HEATED, GIVE TEMPERATURE ____°F SPRAY PRESSURE ____ PSI FREEBOARD HEIGHT ____ FT	
9. OPERATING PROCEDURE	
CAN DEGREASER COVER BE CLOSED DURING DEGREASER OPERATION? YES ☐ NO ☐	
IS DEGREASER COVER CLOSED WHEN DEGREASER IS NOT IN USE? YES ☐ NO ☐	
ARE PARTS DRY BEFORE REMOVAL FROM DRYING RACK? YES ☐ NO ☐	
HOW IS WASTE SOLVENT DISPOSED OF: _____	
FREQUENCY OF MAKEUP _____	
10. CONTROL DEVICES:	
REFRIGERATION CHILLERS YES ☐ NO ☐	
CARBON ADSORPTION YES ☐ NO ☐	
WATER COVER YES ☐ NO ☐	
FREEBOARD RATIO ≥ 0.7 YES ☐ NO ☐	
11. DESCRIPTION OF MAINTENANCE PROGRAM: _____	

2.4.2.2 Review Waste Solvent Disposal Procedures

A description of waste solvent disposal methods used by the source must be requested in the questionnaire initiated by the agency (example shown in Figure 2-7). A comparison should be made with the RACT operating requirements ("not greater than 20 percent can evaporate into the atmosphere"), and data on other acceptable practices which are readily available.

Several acceptable methods for disposing of waste solvent were briefly discussed in Section 2.3. Common disposal methods that do not meet the RACT guidelines include flushing waste solvent into sewer lines and spreading waste solvent on parking lots and roadways for dust control purposes.

CHAPTER 3

OPEN TOP VAPOR DEGREASERS

3.1 PROCESS DESCRIPTION

3.1.1 Unit Operation

Open top vapor degreasers provide an efficient and economical method for preparing clean, dry articles for subsequent finishing or fabricating. There are several configurations in use for open top degreasers; all are similar in basic design. In the simple vapor method, cleaning results from the condensation of solvent vapors on the cool surface of the article; the dissolving and flushing action of the condensate removes the soil. When the article reaches the temperature of the solvent vapor, no more condensation (or cleansing) occurs and the article is removed from the vapor zone. Other cleaning methods involve various combinations of the simple vapor method with immersion and spray-ind with liquid solvent.

Open top vapor degreasers utilize nonflammable solvent contained in the lower area of the degreaser, referred to as the boiling sump. The solvent is boiled to produce a vapor zone, the height of which is controlled by cooling coils installed above the vapor zone. The "cold work" introduced into the vapor space of the degreaser must be at a temperature lower than the vapor zone in order to cause the solvent vapors to condense on the work surfaces and flush the oil and other foreign matter off with the liquid condensate. The removed material accumulates in the boiling sump and only the pure vapor comes in contact with the work load. In either case, flushing is often followed by pure solvent spray and/or liquid immersion. The cool, pure liquid solvent reduces the temperature of the work surface below the vapor temperature, producing a second vapor condensation flushing action on the work surfaces. When the work pieces are removed from the degreaser, they should be clean, dry, and ready for further processing.

3.1.2 Types of Open Top Vapor Degreasers

Open top vapor degreasers are most suitable in situations where the work flow is variable or intermittent. Otherwise, a conveyORIZED degreaser might be the equipment preferred. Essentially, there are three variations of vapor degreasing: (1) straight vapor, (2) liquid immersion-vapor, and (3) vapor-spray-vapor degreasing.

- o Straight Vapor: In this unit, the article to be cleaned is lowered into the vapor zone and held there until it reaches the vapor temperature, at which point vapors cease condensing on the article. It is gently agitated to enhance drainage of trapped liquid solvent. Then, it is brought into the freeboard area and allowed to dry for a moment before being removed from the degreaser. Figure 3-1 is a cut away sketch of a straight vapor degreaser. As with any open top arrangement, the work to be cleaned may be lowered manually or with an overhead hoist with hooks or long handle baskets. Hands should never be placed below the vapor line.
- o Liquid Immersion - Vapor: Immersion of the work in the hot or boiling solvent is preferred; (i) for closely nested work, (ii) for excessive soil levels (iii) for light gauge work, (iv) when ultrasonics is necessary, and (v) for parts with intricate patterns. Figures 3-2 to 3-4 show various equipment configurations for this technique. Typically, the work is lowered into the vapor zone for a straight vapor rinse, then lowered into the liquid immersion chamber to be rinsed. This will cool the work slightly. Then, the work is raised into the vapor zone for a second vapor rinse. The 2-compartment unit shown in Figure 3-3 may be operated in this fashion or, if necessary for proper cleaning, the work may be lowered directly into the boiling sump, then rinsed in the condensate reservoir. (Care should be taken not to drag dirty solvent from the boiling liquid tank to the rinse tank). After the liquid rinse the work is given a vapor rinse above the condensate reservoir. The reservoir is often heated to ensure that the liquid rinse is warm. Similarly, the 3-compartment unit depicted in Figure 3-4 may be outfitted to operate with two or three liquid immersions.
- o Vapor - Spray - Vapor: This is similar to straight vapor degreasing except that as soon as the work is below the vapor level, it is sprayed with cool condensate. After spraying is complete the work should remain in the vapor zone until it reaches the vapor temperature and condensation has stopped. Figure 3-5 is a schematic of a spray unit with an offset condenser. Spraying should be done as far below the top of the vapor line as possible so that evaporative losses due to spraying are minimized.

Some units, especially larger ones, are equipped with a lip exhaust. A lip exhaust draws air laterally across the top of the degreaser and vents the air directly to the roof or to a carbon adsorption unit. Figure 3-6 is a schematic of one of these units. The primary purpose of a lip exhaust is to limit worker exposure to solvent vapors.

Figures 3-7 through 3-9 are photographs of three variations of open top vapor degreasers. The unit in Figure 3-8 relates directly to the schematic in Figure 3-3. The physical dimensions of these units varies widely. For example, the vapor-spray unit in Figure 3-7 commonly is purchased in several sizes ranging from 2 feet wide by 4 feet long by 4 1/2 feet high to 4 feet wide by 12 feet long by 9 1/2 feet high. Larger sizes are available on special order.

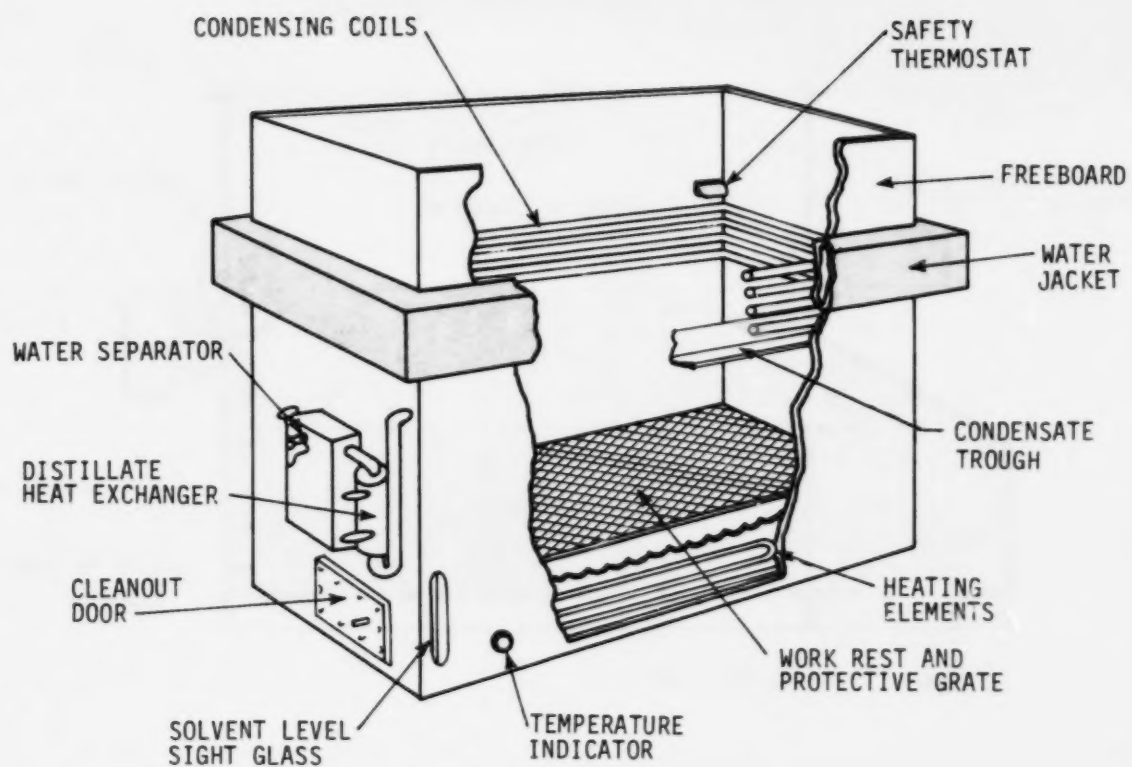


Figure 3-1. Single Compartment Vapor Degreaser

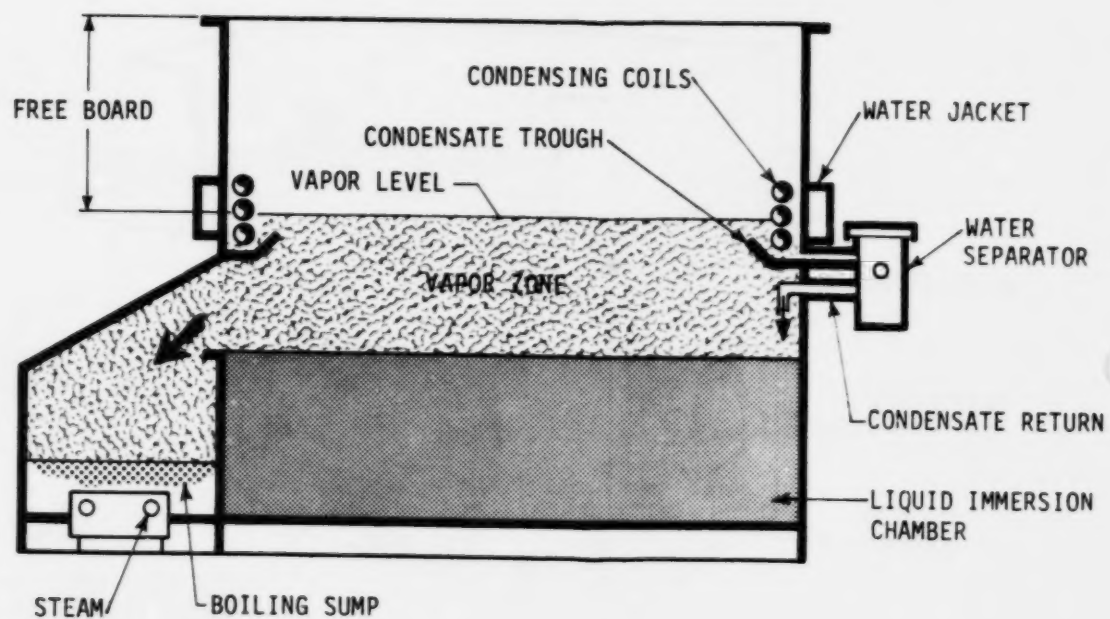


Figure 3-2. Liquid-Vapor Degreaser

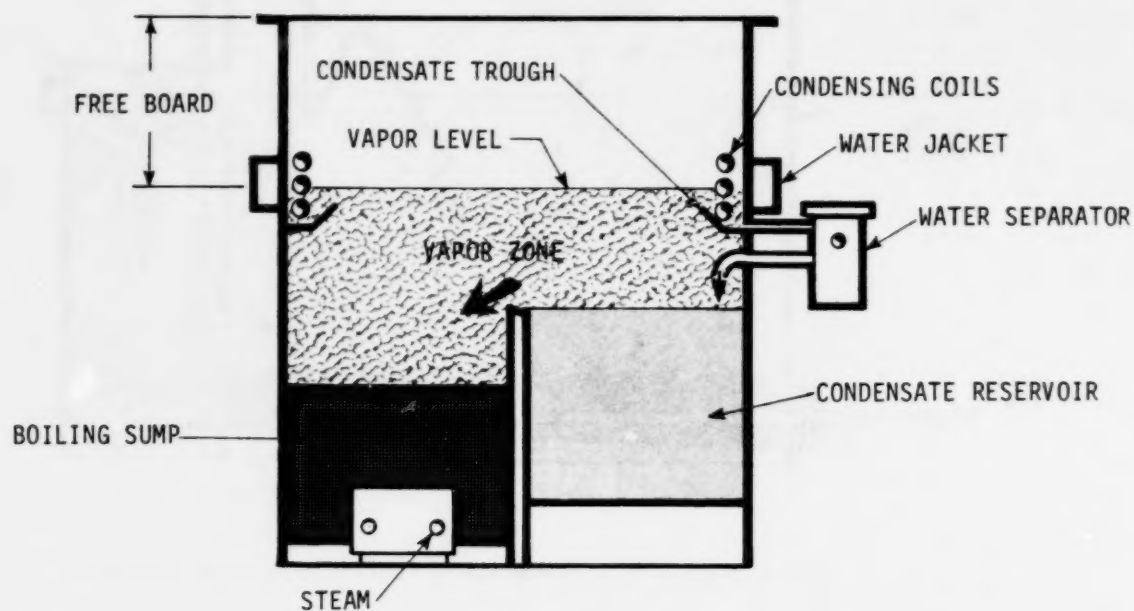


Figure 3-3. Liquid-Liquid-Vapor Degreaser 2 Compartment

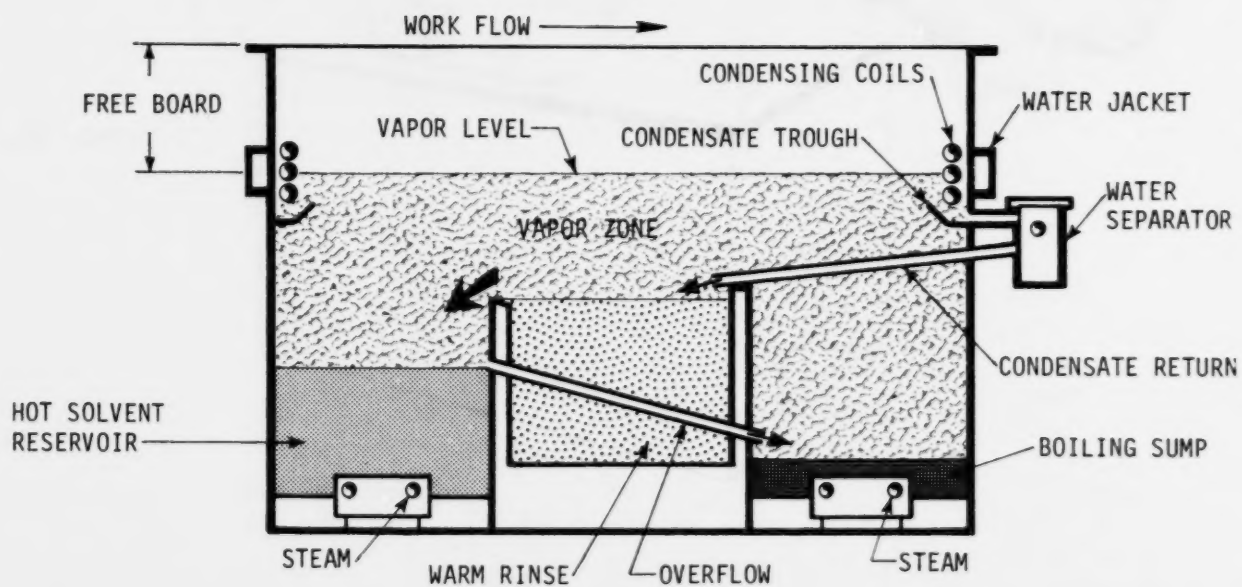


Figure 3-4. Liquid-Liquid-Vapor Degreaser 3 Compartment

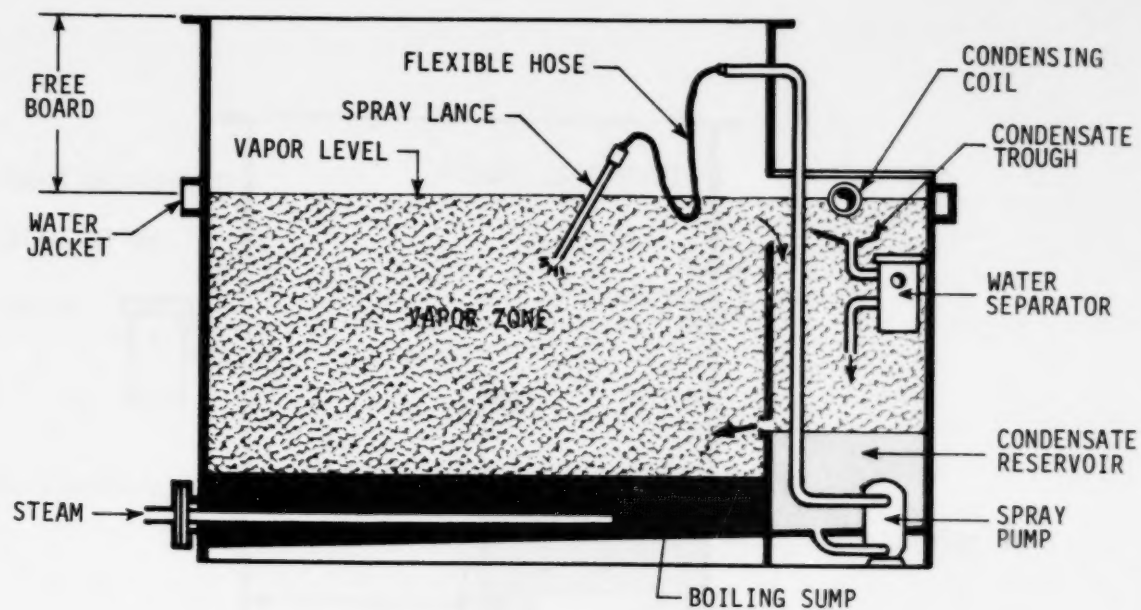


Figure 3-5. Offset Condenser Vapor-Spray-Vapor Degreaser

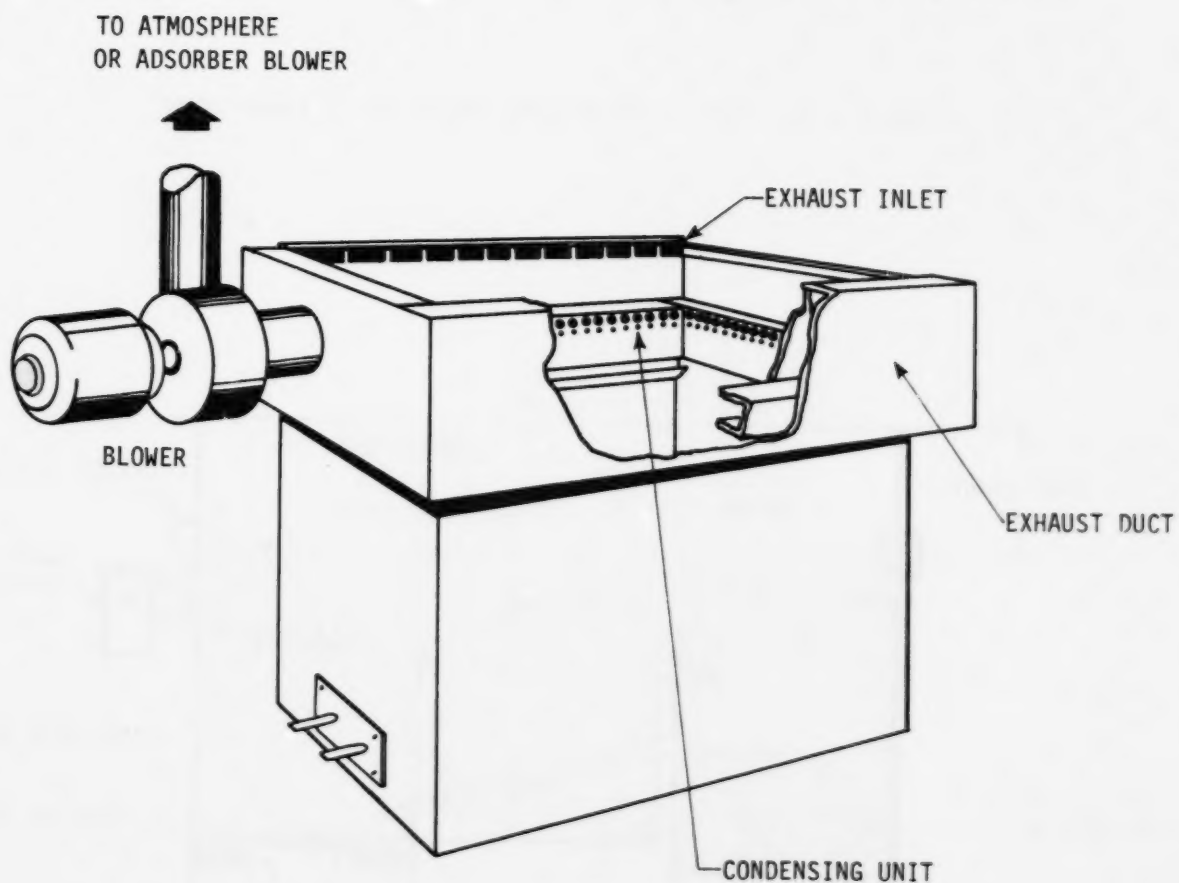


Figure 3-6. Degreaser with Lip Exhaust

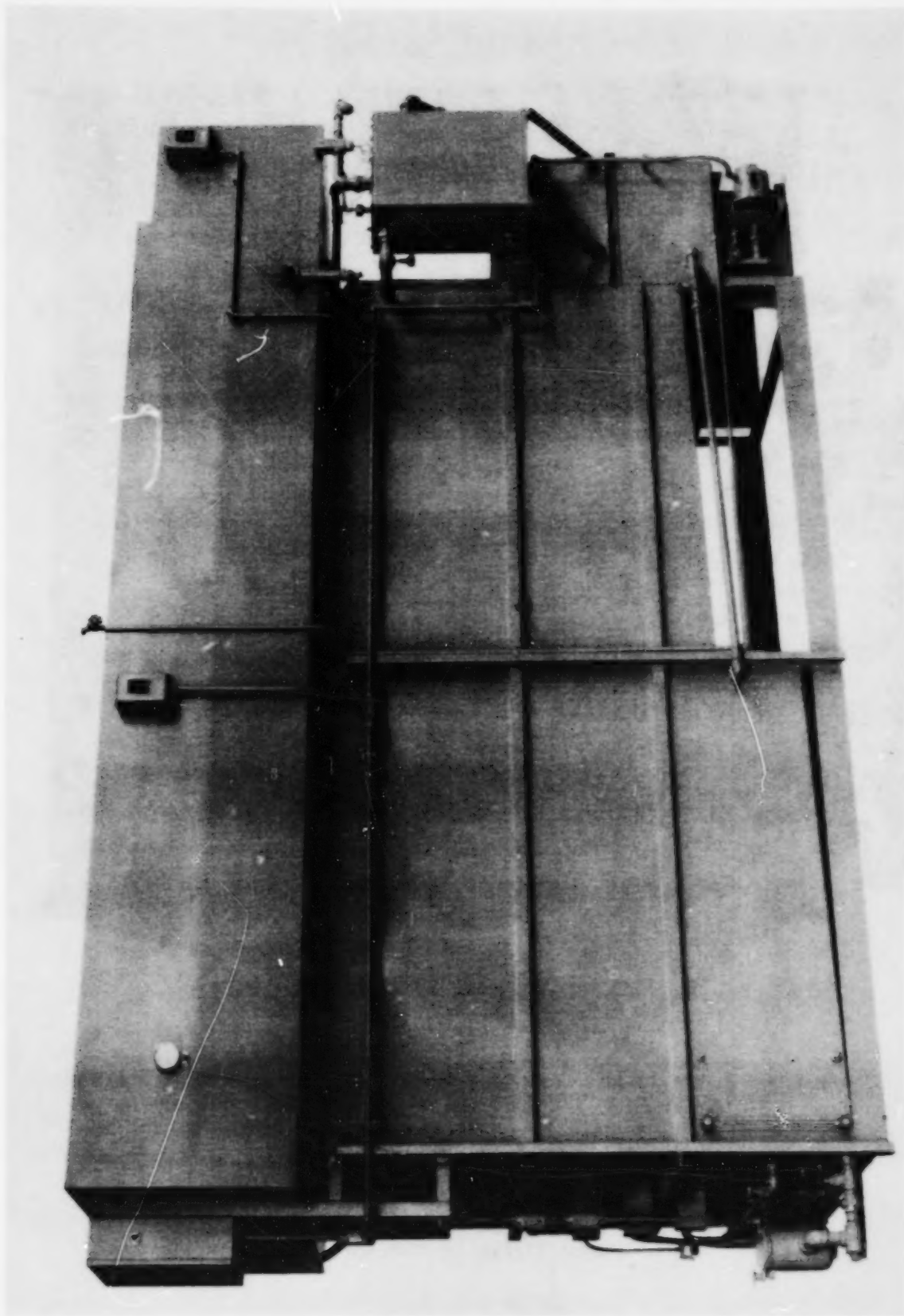


Figure 3-7. Perimeter Condensing Vapor-Spray-Vapor Degreaser
(Baron Blakeslee, Chicago, Illinois)

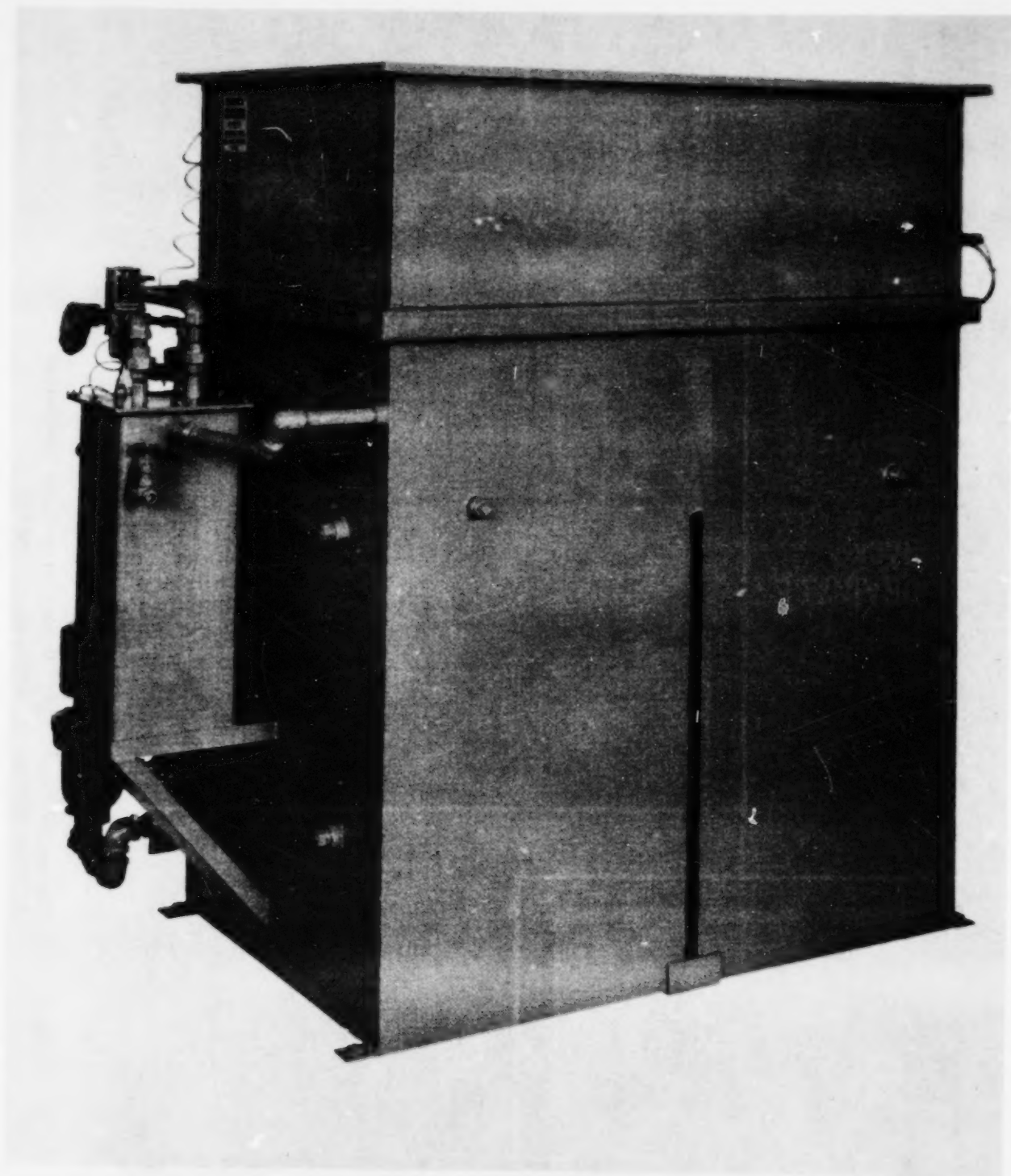


Figure 3-8. Liquid-Liquid-Vapor Degreaser 2 Compartment
(Baron Blakeslee, Chicago, Illinois)

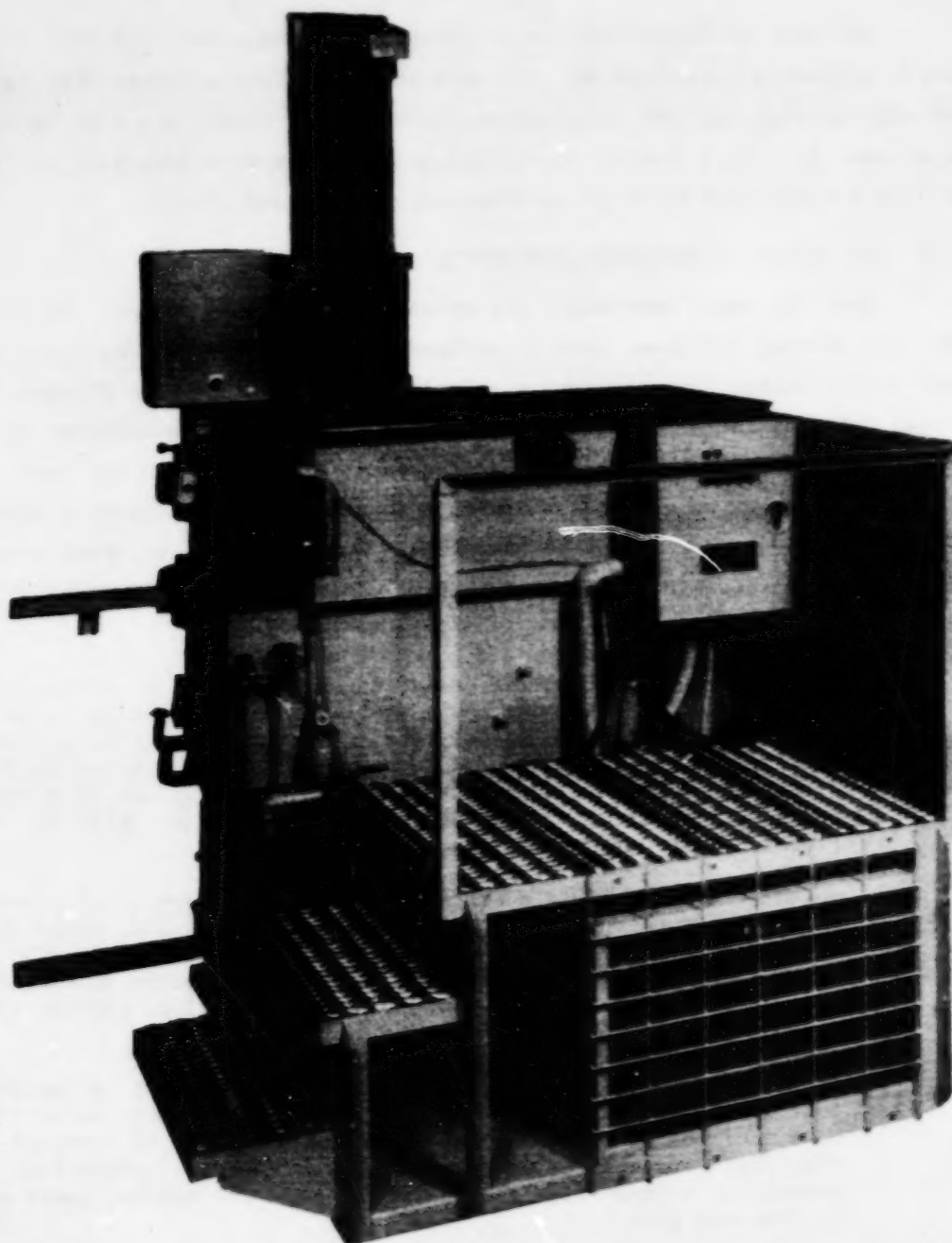


Figure 3- 9. Liquid-Liquid-Vapor Degreaser 3 Compartment With Automatic Dip
(Delta Industries, Santa Fe Springs, California.)

The unit in Figure 3-9 is a 3 compartment degreaser that is outfitted with an automatic hoist system. The work is loaded into a basket that is automatically carried through the cleaning cycle. As pictured, the work is in compartment #1. Note that as the mechanism moves the work from left to right and back a horizontal cover is automatically opened and closed.

3.1.3 Operation of Degreaser Components

Open top vapor degreasers are relatively simple in design. Although there are several different common configurations and optional features, they share common design characteristics. Typical units, as shown in Figures 3-1 through 3-6, consist of a boiling sump, cooling coils, a work delivery system, a vapor space above the boiling sump, a freeboard, safety thermostats, and a water separator. Most units are equipped with a downtime cover to minimize solvent loss when the degreaser is not in operation. Some units are equipped with a liquid spray, ultrasonic cleaning mechanism, water jacket, or lip exhaust.

Brief descriptions of the primary components follow:

- o Boiling Sump - The boiling (solvent) sump is located in the bottom section of the degreaser and includes the heating coils for vaporizing the liquid solvents. Steam, electricity, and gas are the mediums normally used to heat the chamber. Steam is often the most economical. Steam is usually supplied by use of a pipe coil in the boiling sump although a steam jacket or panel may be preferable in certain designs.

In those cases where electricity is the heating method of choice, immersion type heaters should be installed on a sturdy support within the boiling sump. Degreasers which are not expected to accumulate metal fines or precipitate other insoluble solids may be adequately heated by strip heaters fastened in close contact with the underside of the sump.

If gas is used for heating, the burner is enclosed in an immersion tube in the boiling sump. The combustion chamber must be of tight construction and the gas flame's air supply should be designed so that fresh air only is fed to the burner. Being a combustion process an exhaust flue is required to vent the exhaust gases out of the work area.

The boiling sump and heating elements (regardless of heating method) should be accessible for cleaning and maintenance. The heating elements usually are removable and access doors are often provided for the sump, especially on larger units.

- o Vapor Zone - The vapor zone is the volume of vapors above the boiling liquid solvent up to the vapor/ambient air interface that occurs at the cooling coils. This area in the degreaser is pure solvent vapor; the solvent vapors are about 4 1/2 times as heavy as ambient air so they are contained quite efficiently within the degreaser to form a vapor zone in which the vapor degreasing actually occurs.

- o Freeboard - The upper body of the degreaser is extended above the cooling coils to provide a "seal" of stagnant air over the vapor zone. This area is referred to as the freeboard and it serves to reduce disturbances at the vapor/air interface thus reducing solvent vapor emissions. It also serves as a disengaging space for the traces of solvent which evaporate from the work as it is withdrawn after cleaning.
 - o Cooling Coils - Cooling (condensing) coils are installed along the inside surfaces of the degreaser; their location defines the upper limit of the vapor space and the lower limit of the freeboard. The coils consist of four or more pipe coils stacked one above the other and located directly above a vapor condensate trough. The cooling medium is normally tap or process water. Usually, the water enters the bottom coil and exits at the top. If the arrangement should be reversed, the bottom exit should be connected to a standpipe at least as high as the condenser so that the condenser will always stay full of water. Sometimes the coils are set along only one side of the degreaser, as shown in Figure 3-5.
 - o Water Separator - Water enters a degreaser from several sources; i.e., condensation of atmospheric moisture on condenser coils, moisture on work pieces being processed, and steam or cooling water leaks. Water forms a low boiling azeotrope with the solvent and is vaporized. Most degreasers are equipped with a water separator because uncontrolled water causes corrosion, shortens solvent life, and increases the vaporization rate of solvent. The condensed solvent-water mixture drops into the condensate trough below the condenser coils and flows by gravity to the separator.
 - o Piping and Sprays - There is a minimum amount of piping included in the degreaser. Leaks should not be tolerated because they represent a source of emission and a loss of valuable material. Drain valves are generally found at the lowest point in the tank. Piping that is under pressure, such as the spray line, is a potential source of leaks. Sprays should be operated within the vapor zone so as to not disturb the air/vapor interface. Some designs spray the material in a contained chamber within the degreaser. A spray safety switch is generally provided to shut off the spray pump when the vapor level drops below the design level.
 - o Water Jacket - A water jacket, where applicable, is installed on the exterior of the degreaser and consists of a box section to contain cooling water circulating around the degreaser in the same approximate area of the cooling coils. This jacket is sometimes referred to as the freeboard cooler. Its function is to prevent convection of solvent vapors up hot degreaser walls. In addition, water jackets may reduce "sidewall radiation" from hot freeboard walls. This heat radiation can increase air turbulence and thus disturb the cold air blanket in the freeboard area. Water jackets are sometimes used in lieu of cooling coils in smaller units.
- Water jackets and cooling coils should not be confused with refrigerated chillers. Chillers are sometimes used in addition to these units in order to increase vapor control efficiency.

- o Covers - An automatic or manual cover should be installed on open top vapor degreasers. The use of such covers reduces solvent losses during idling and downtime. A simple lid type cover is effective if utilized by operating personnel. Newer units often are equipped with mechanisms that are more easy to use, and hence more frequently used. The more popular manual designs open and close in a horizontal motion, so that the air/vapor interface disturbance is minimized. These types of covers include roll type plastic covers, canvas curtains and quillotine covers. It is usually advantageous on larger open top vapor degreasers to power the cover. This may be done pneumatically or electrically, usually by manual control with an automatic cutoff. The most advanced covering systems are automated in coordination with the hoist or conveyor. The cover can be designed so it will close while the parts are being cleaned and dried. Thus, the cover is open for only a short period of time when the parts are actually entering or exiting the degreaser.

- o Safety Switches - A variety of safety switches are available to prevent emissions or damage to the equipment during a malfunction. (1) The most important safety switch is the vapor level control thermostat. This device turns off the sump heat if the vapor zone rises above the design level. When hot vapors are sensed above the cooling coils the sump heater is turned off, thus minimizing solvent vapor losses. (2) The condenser water flow switch and thermostat turns off the sump heat when either the condenser water stops circulating or the condenser water becomes warmer than specified. (3) The boiling point in the sump increases as the solvent becomes contaminated with oils, grease and other materials. To prevent the sump from becoming too hot, thus causing solvent decomposition, the sump thermostat cuts off the heat when the sump temperature rises significantly above the solvent's boiling point. (4) The sump can become too hot also if the liquid level drops and exposes the heating elements. Thus, some units are equipped with a solvent level control that cuts off the heat if the liquid level in the boiling sump drops down to the level of the sump heater coils. (5) Spraying above the vapor line can cause excessive emissions, so a few units are equipped with a spray safety switch that turns off the spray pump if the vapor level drops below a specified level.

As a minimum, the vapor level control thermostat should be of the manual reset type. Some manufacturers install manual reset switches for all of the safety switches they install on a unit.

- o Water Regulating Valve - To minimize water consumption, some units are equipped with a water regulating valve installed at the water outlet of the cooling coils. A constant temperature is automatically maintained at the outlet of the coils by the valve's temperature bulb. The valve opens on temperature rise, closes on temperature drop.

- o Ultrasonics - If parts are immersed in the liquid solvent, cleaning may be enhanced by vibrating the solvent with high frequency sound waves. To optimize cavitation at the surface of the work the solvents need to be heated to specific temperatures. Cavitation is the implosion of microscopic vapor cavities within the liquid solvent.

3.2 ATMOSPHERIC EMISSIONS

3.2.1 Emission Points

There are several means by which organic solvent vapors can be emitted to the atmosphere in an open top vapor degreaser. These are identified in Figure 3-10. In general, open top units are not hooded or vented to the outside. Thus, an obvious emission point is the direct diffusion and convection of vapors from the vapor zone to the atmosphere (Location 1). If a lip exhaust is installed some of these vapors can be directed to a roof vent (Location 2). If not properly designed, these systems can actually increase solvent evaporation, especially if the exhaust rate is excessive, causing disruption of the air/vapor interface. The use of lip (or lateral) exhausts is usually limited to larger than average degreasers where the primary objective is to limit worker exposure to solvent vapors. A rule of thumb used by degreaser and control systems manufacturers is to set the exhaust rate at 50 cubic feet per minute per square foot of degreaser opening. If this exhaust rate is not adequate to protect the workers, higher rates may be encountered.

Carry-out emissions result from solvent that has condensed on the work and has not fully evaporated before being removed from the degreaser (Location 3). Also, solvent vapors may be entrained by the motion of removing the work from the vapor zone or by convection due to the hot work heating the solvent laden air as it is removed from the vapor zone. Porous or adsorbant materials such as cloth, leather, wood or rope will adsorb and trap condensed solvent and thus such materials should never enter a degreaser.

As the solvent material is spent and itself becomes contaminated with impurities its usefulness decreases. To reduce the volume of waste material some degreasers are used as a simple still during downtime where the solvent in the sump is boiled off as much as feasible and the pure condensed vapors are piped off to a storage tank, rather than back to the sump. Other degreasers, especially the larger ones, may be used with an external still that may run on a continuous or batch basis. Nevertheless, a significant volume of waste material will remain to be disposed of and depending on the method of disposal, waste solvents may enter the atmosphere (Location 4).

Fugitive emissions can occur at any of the piping connection or pump seals that may have loosened, or become worn or corroded (Location 5). These emission points are usually eliminated fairly quickly because they are detectable by visual observation and represent a correctable loss of valuable material, and create a potentially unhealthy work environment.

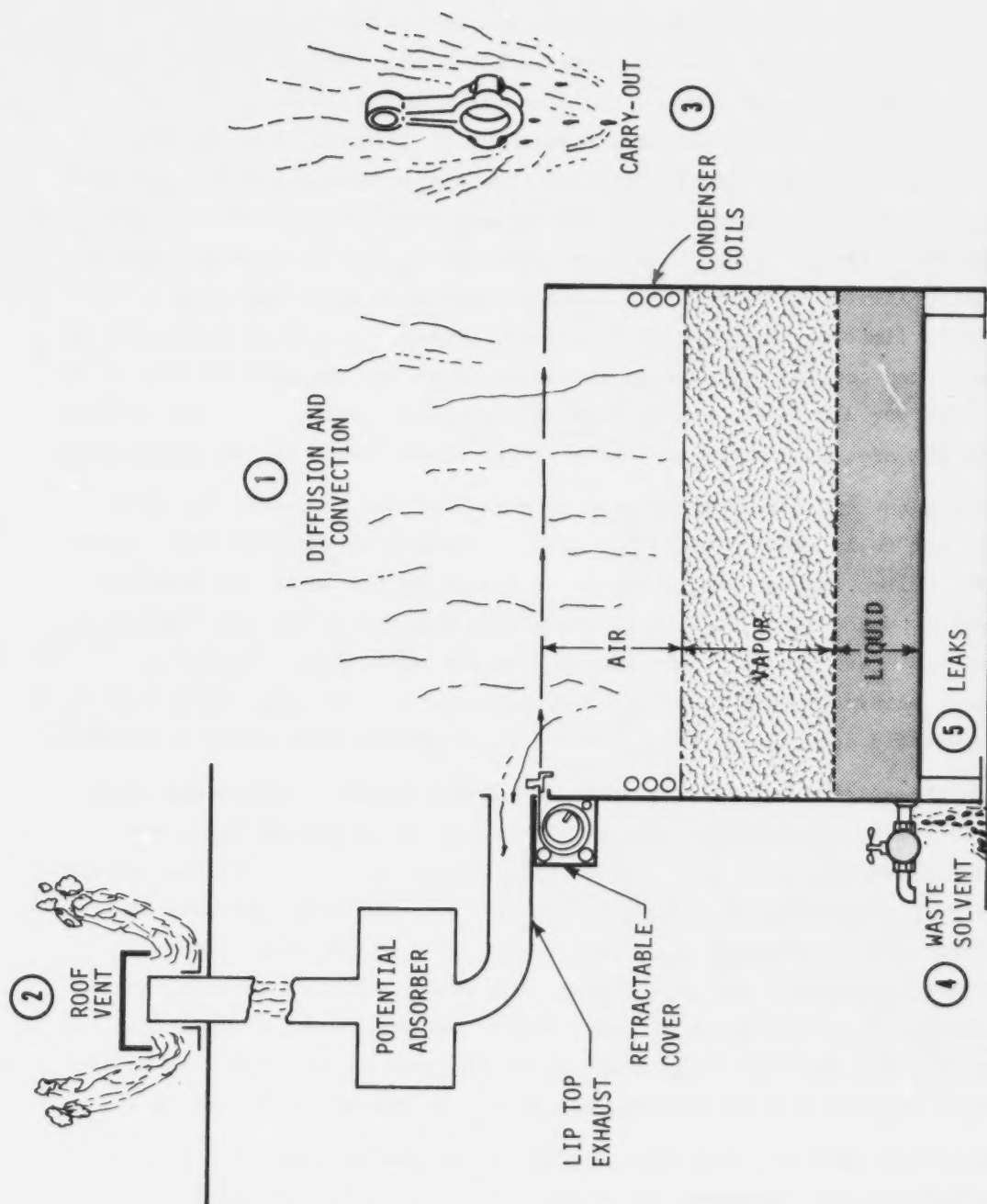


Figure 3-10. Open Top Degreaser Emission Points

3.2.2 Parameters Affecting Rate of VOC Emissions

The rate of vapor emissions emanating from the various points previously discussed is dependent on a variety of operating and design parameters. Emissions can be minimized by attempting to achieve certain optimum conditions; however, it is important to understand the cause and effect relationship. The following parameters significantly affect VOC emissions from open top vapor degreasers:

- o Freeboard Ratio - The freeboard ratio is the ratio of the freeboard height to the width (not the length) of the degreaser. Manufacturers of degreasers generally size the equipment so that this ratio is at least 0.5 for the higher boiling solvents. For solvents with lower boiling points, such as methylene chloride and trichlorotrifluoroethane, this ratio should be at least 0.75.
- o Drafts - A fan or other air moving devices located in the work area near the degreaser can cause a draft to enter the freeboard area of the degreaser housing, thereby upsetting the interface and drawing vapors into the ambient air.
- o Type of Work Load - Atmospheric emissions increase when the parts being processed in the degreaser contain numerous pockets or liquid traps that allow liquids to be carried from the degreaser chamber.
- o Size of Work Load - If the cross-sectional area of the work is substantial compared to the cross-sectional area of the vapor chamber, moving the work in and out of the degreaser will have a piston effect on the surrounding vapors; the resulting turbulence will cause excessive emissions.
- o Mass of Work Load - If the work load is especially massive the heat required to bring the work to vapor temperature will be excessive. This will cause the vapor zone to collapse resulting in turbulence that will increase emissions.
- o Solvent Heat Input - Once the solvent's boiling temperature has been achieved, increasing the heat input to the solvent will increase the rate of solvent vaporization. If continued, the cool air blanket generated by the condenser coils may not be sufficient to retain the increased vapors and breakthrough could occur, resulting in greater emissions.
- o Temperature and Flow Rate of the Cooling Water - The function of a condensing coil is to limit the upper level of the vapor zone. A condenser consisting of a coil of pipe through which cooling water flows, creates a blanket of cool air. The flow rate and temperature of the water affect the efficiency of a given set of coils with a given heat input rate. Increasing flow increases efficiency. Decreasing the temperature of the water will also increase the efficiency of the coils in supporting the vapor layer.

- o Work Rate - Moving the work into and out of the degreaser creates turbulence that will result in the emission of vapors. Turbulence and the resulting emissions increase as the speed of the work increases.
- o Location of Spraying - If spraying is conducted in a manner that disrupts the vapor/air interface, emissions will increase. Spraying should be done below the vapor line; the spray should never be pointed to allow liquid to be sprayed above the vapor line.
- o Water in the Solvent - If water is allowed to accumulate in the boiling sump emissions may be increased in three ways: (i) the water/solvent vapor mixture has a lower density than pure solvent vapor and thus has a greater tendency to be lost by diffusion, (ii) water combines with the solvent to form a low boiling azeotrope that results in a higher vaporization rate, and (iii) water is corrosive to degreaser surfaces and piping, thus making leaks a serious problem. Water has a tendency to form acidic by-products with certain solvents, especially 1,1,1 - trichloroethane and methylene chloride, further exacerbating the corrosion problem.
- o Covers - The use of a cover during idle and down time virtually eliminates diffusion losses during these periods.
- o Drying Time - After the work has been removed from the vapor zone it may carry some condensed solvent out of the degreaser. To minimize these emissions the work should be allowed to dry for a brief time (about 15 seconds) in the freeboard area. Note, however, that when the hot part rests just above the vapor level, it will cause solvent laden air to heat up and rise, so the drying time should not become excessive.
- o Lip Exhaust - If the degreaser is equipped with a lip exhaust, the ventilation rate should not be excessive; otherwise, the exhaust system may disrupt the air/vapor interface and actually increase emissions.

3.3 EMISSION CONTROL METHODS

The EPA Control Technology Guideline document for solvent metal cleaning identifies a number of control strategies for reducing volatile organic emissions from open top vapor degreasers. These form the basis for defining RACT for these degreasers and should therefore be the focal point of a field investigation. The CTG document suggests two alternative control schemes. Level A represents a relatively low efficiency system consisting primarily of operating procedures and has an estimated efficiency of 45 (+15) percent. Level B consists of Level A plus additional control and has a control efficiency estimated at 60 (+15) percent. These control methods are presented in Table 3-1. EPA's policy regarding the application of these control levels is discussed in Chapter 1. EPA suggests that open top vapor degreasers with an open area of less than one square meter be exempt from the application of refrigerated chillers or carbon adsorbers because these devices would not be cost effective on such small units.

The safety switches and thermostat recommended in Control System B are the spray safety switch, the condenser flow switch and thermostat. The vapor level thermostat is not included because it is already required by OSHA on "open surface vapor degreasing tanks". The sump thermostat and solvent level control discussed in Section 3.1.3 are used primarily to prevent solvent degradation and protection of the equipment rather than to prevent solvent emissions.

Refrigerated chillers should not be confused with the condenser coils or water jacket; rather, the chillers are an optional, additional control device designed to minimize solvent losses. The refrigerated chiller consists of a second set of condenser coils located slightly above the primary coils. Figure 3-11 depicts a unit with finned chiller coils. The function of the primary coils remains as in units without freeboard chillers, i.e. to control the upper limit of the vapor zone. The refrigerated freeboard chiller creates a sharper temperature gradient than would otherwise exist. The resulting cold air blanket reduces diffusion losses and the stable inversion layer created by the increased temperature gradient decreases upward convection of solvent laden air.

Two types of chiller designs are commercially available; one that operates below 0°C and one that operates above that temperature. Most manufacturers of degreasing equipment offer both types, although there is a patent* on the sub-zero design.

*U.S. Patent 3,375,177 issued to Autosonics, Inc., March 26, 1968

TABLE 3-1

COMPLETE CONTROL SYSTEMS FOR OPEN TOP VAPOR DEGREASERS

Control System A

Control Equipment:

1. Cover that can be opened and closed easily without disturbing the vapor zone.

Operating Requirements:

1. Keep cover closed at all times except when processing work loads through the degreaser.
2. Minimize solvent carry-out by the following measures:
 - a. Rack parts to allow full drainage.
 - b. Move parts in and out of the degreaser at less than 3.3 m/sec. (11 ft/min).
 - c. Degrease the work load in the vapor zone at least 30 sec. or until condensation ceases.
 - d. Tip out any pools of solvent on the cleaned parts before removal.
 - e. Allow parts to dry within the degreaser for at least 15 sec. or until visually dry.
3. Do not degrease porous or absorbent materials, such as cloth, leather, wood or rope.
4. Work loads should not occupy more than half of the degreaser's open top area.
5. The vapor level should not drop more than 10 cm (4 in.) when the work load enters the vapor zone.
6. Never spray above the vapor level.
7. Repair solvent leaks immediately, or shutdown the degreaser.
8. Do not dispose of waste solvent or transfer it to another party such that greater than 20 percent of the waste (by weight) will evaporate into the atmosphere. Store waste solvent only in closed containers.
9. Exhaust ventilation should not exceed $20 \text{ m}^3/\text{min. per m}^2$ (65 cfm per ft^2) of degreaser open area, unless necessary to meet OSHA requirements. Ventilation fans should not be used near the degreaser opening.
10. Water should not be visually detectable in solvent exiting the water separator.

Control System B

Control Equipment:

1. Cover (same as in system A).
2. Safety switches.
 - a. Condenser flow switch and thermostat - (shuts off sump heat if condenser coolant is either not circulating or too warm).
 - b. Spray safety switch - (shuts off spray pump if the vapor level drops excessively, about 10 cm (4 in)).
3. Major Control Device:

Either:

 - a. Freeboard ratio greater than or equal to 0.75, and if the degreaser opening is $>1\text{m}^2$ (10 ft^2), the cover must be powered,
 - b. Refrigerated chiller,
 - c. Enclosed design (cover or door opens only when the dry part is actually entering or exiting the degreaser),
 - d. Carbon adsorption system, with ventilation $>15 \text{ m}^3/\text{min per m}^2$ (50 cfm/ ft^2) of air/vapor area (when cover is open), and exhausting $<25 \text{ ppm}$ solvent averaged over one complete adsorption cycle, or
 - e. Control system, demonstrated to have control efficiency, equivalent to or better than any of the above.
4. Permanent, conspicuous label, summarizing operating procedures #1 to #6.

Operating Requirements:

Same as in System A

The recommended operating temperature for below freezing chillers is -30 to -25°C. The cold coils attract moisture as does a dehumidifier. Therefore, the designs include a defrost cycle to remove frost from the coils and restore heat exchange efficiency. The defrost cycle operates approximately hourly, requiring only a few minutes to melt the accumulated ice and slush, which is collected in the condensate trough and poured through the water separator. Water contamination of the solvent can have an adverse affect on water soluable stabilizer systems and can contribute to equipment corrosion. Therefore, on some units, the material condensed from the chiller coils may be diverted to a different water separater.

The operating temperature of above freezing chillers should not exceed 5°C. These units are normally designed to achieve a minimum of 500 Btu/hr cooling capacity per foot of air/vapor interface perimeter. The sub-freezing units are normally designed in the range of 200-600 Btu/hr per foot of perimeter, depending on the width of the degreaser.

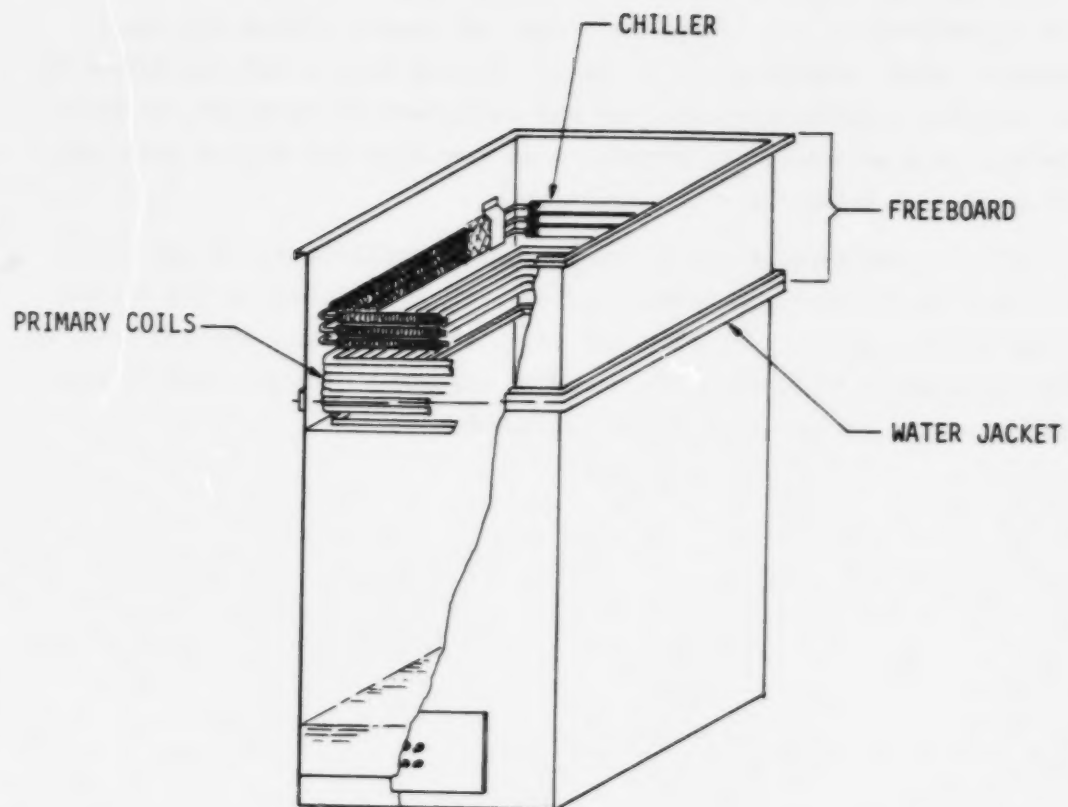


Figure 3-11. Refrigerated Freeboard Chiller

3.4 INSPECTION PROCEDURES

The following paragraphs discuss two types of inspections: (1) field review and (2) office review. Source sampling, still another form of inspection, will be discussed in Chapter 5.

Field investigations range from brief plant visits to thorough inspections and testing programs that produce a complete data base for enforcement proceedings. Office reviews rely on the source to furnish information through written material such as permit applications and responses to Section 114 inquiries. This approach may require less time and manpower but the resulting data base is generally less complete. Office reviews, however, provide a useful screening tool in those cases where there is a large number of potential violators.

3.4.1 Field Inspections

After becoming familiar with the plant and its facilities, the inspector should request that the appropriate company official give him information from company records that will allow the inspector to begin completing the worksheets shown in Figure 3-12. The data may also be available from permit applications. The worksheet divides the required data into two categories: control equipment and operating requirements. It also provides the RACT requirements for each category with a suggested inspection procedure. With such information, direct comparisons can be made between the RACT requirements and observed practices.

Generally, the inspector would next request the company's assistance in conducting a full inspection of the facility in order to verify the actual operating conditions. This inspection may take several hours depending on the number and types of open top vapor degreasers. The inspector must collect information that will allow him to complete the inspection worksheet. All field data, such as temperature of the coolant, exhaust flow rate, etc., should be observed and verified by the air pollution inspector. For equipment that is operating, the inspector must be prepared to collect this data with his own resources.

This information will be compared to the data given by the company official, and the total data base will be compared to the RACT requirements for control equipment and operating conditions to determine if a violation exists. At that time, a reinspection date should be established if it is determined that the source is not in compliance.

FIGURE 3-12

EXAMPLE WORKSHEET FOR FIELD INSPECTION OF

OPEN TOP VAPOR DEGREASERS

1. BUSINESS LICENSE NAME OF CORPORATION, COMPANY, OR INDIVIDUAL OWNER OR GOVERNMENTAL AGENCY:		
2a. MAILING ADDRESS:	2b. PLANT ADDRESS WHERE THIS DEGREASER IS LOCATED:	
3. SOURCE NO. (PERMIT NUMBER, NEDS ID, ETC.)		
4. NAME AND TITLE OF COMPANY REPRESENTATIVE:		
5. TELEPHONE NO.:		
6. NAME OF OFFICIAL CONDUCTING INSPECTION:		
7. DEGREASER		
MANUFACTURER:	MODEL NO.	SERIAL NO.
INSIDE DIMENSIONS OF TANK (FT.):	WIDE X	LONG X DEEP
8. TITLE AND CODE NUMBERS OF DRAWINGS, SPECIFICATIONS, STANDARDS, CODES, PROCEDURES AND DOCUMENTS USED WITH THE INSPECTION		
9. TYPE OF SOLVENTS IN USE (SPECIFIC NAME AND MANUFACTURER):		
INSPECTION OBSERVATIONS		
RACT REQUIREMENTS	SUGGESTED INSPECTION PROCEDURE	FIELD OBSERVATIONS
<u>CONTROL EQUIPMENT</u>		
1. Lid	Observe if a lid is installed and if it is used during idling and downtime. Observe if opening and closing the lid disturbs the vapor zone.	
2. Safety Switches a. Condenser flow switch & thermostat	- Confirm that the switch and thermostat have been installed. - If available, check readings of flow and temperature indicators. For high boiling solvents, the temperature should be about 8° to 11°C (15° to 20°F) above dewpoint of surrounding atmosphere or 32° to 46°C (90° to 115°F). For low boiling solvents (methylene chloride and fluorocarbon 113) the exit temperature should be less than 29°C (85°F). Many installations may not have a temperature indicator at the cooling coil exit. A rough estimate of the temperature may be made if a bleed valve is available at the exit end of the coils. Bleed a sample of coolant into a small vessel and measure the temperature with a portable thermometer. - If plant is agreeable, interrupt flow of coolant and determine if switch is tripped.	

FIGURE 3-12

(Continued)

RACT REQUIREMENTS	SUGGESTED INSPECTION PROCEDURE	FIELD OBSERVATIONS
b. Spray safety switch	Confirm that the switch has been installed.	
3. Major Control Devices a. Freeboard ratio greater than 0.75. b. If the degreaser area is greater than 1.0m² the cover must be powered. c. Refrigerated Chiller d. Enclosed Design	- Measure the height of the freeboard and the width of the tank; calculate the ratio. (Measurements usually can be made externally to avoid creating emissions and breathing solvent vapors. Otherwise, obtain the measurements from shop drawings). Measure the length of the tank and calculate the degreaser area. Observe if the cover is powered. - Unless observed during the defrost cycle, sub-zero chillers should be coated with frost or slush. The indicated temperature of the coolant should not exceed -25°C (-13°F). Do not attempt to extract a sample of coolant from a refrigerated chiller. - For above freezing chillers the coolant temperature should not exceed 5°C (40°F). - Determine the cooling capacity from the design specifications. - For subzero chillers the minimum cooling capacity should be as follows for each degreaser width: (The cooling units are Btu's per hour per foot of perimeter.) <3.5 ft - 200 >3.5 ft - 300 >6 ft - 400 >8 ft - 500 >10 ft - 600 - For above freezing chillers the cooling capacity should be at least 500 Btu/hr per foot of perimeter. - Observe that the cover or doors are open only when the dry part is entering or exiting the degreaser.	

FIGURE 3-12

(Continued)

RACT REQUIREMENTS	SUGGESTED INSPECTION PROCEDURE	FIELD OBSERVATIONS
e. Carbon Adsorber	- o If the degreaser is equipped with an adsorber solvent odors should not be detectable on the roof downwind from the stack. - o See the source testing section in this manual.	
<u>OPERATING REQUIREMENTS</u>		
1. Keep cover closed except while processing work loads.	o Observe the operation.	
2. Minimize solvent carry-out by the following measures: a. Rack parts to allow full drainage. b. Move parts in and out of degreaser at less than 3.3 m/sec (11 ft/min). c. Degrease parts for at least 30 seconds or until condensation stops. d. Tip out pools of solvent on the cleaned parts before removal. e. Allow parts to dry within the degreaser for at least 15 seconds or until visually dry.	- o Observe how the parts are racked. - o Using a stopwatch, time the vertical movement of parts over a measured distance. - o Observe this operation and time it if necessary. - o Observe this operation. - o Observe this operation, time it if necessary.	
3. Do not degrease porous or absorbant materials.	o Note the nature of the materials being cleaned. Baskets should not have rope or leather handles.	
4. Work loads should not occupy more than half of the degreasers open top area.	o Observe the size of the work load. Measure it if necessary and compare it to the open top area.	
5. The vapor level should not drop more than 10 cm (4 inches) when the work load enters the vapor zone.	o Observe this operation and estimate the drop in the vapor level.	
6. Never spray above the vapor line.	o Observe this operation.	
7. Repair solvent leaks immediately or shut down the operation.	o Look for leaks around the degreaser. Note especially the solvent spray pump and line, piping, the external sump drain valve (if so equipped) and the water separator.	

FIGURE 3-12

(Continued)

RACT REQUIREMENTS	SUGGESTED INSPECTION PROCEDURE	FIELD OBSERVATIONS
8. Do not dispose of waste solvent or transfer it to another party such that greater than 20 percent of the waste (by weight) can evaporate into atmosphere. Store waste solvent only in covered containers.	- o Determine if source has inhouse reclamation facilities (i.e. still) or a service contract with a solvent reclamation firm. - o Confirm that storage is done with covered containers by visual inspection. Note whether containers leak.	
9. a. Exhaust ventilation should not exceed $20\text{m}^3/\text{min}$ per m^2 (65 cfm per ft^2) of degreaser open area unless necessary to meet OSHA requirements. b. Ventilation fans should not be used near degreaser opening.	- o Determine the air handling capacity of the fan, -or- If sampling ports are available, the velocity of the exhaust gases may be measured with a swinging vane velocity meter. Also determine the cross-sectional area of the duct, then calculate the cfm. - o After the air volume is determined from either of the above methods, obtain the area of the degreaser opening and calculate the cfm per square foot of degreaser opening. - o Note the location of ventilation fans near the degreaser.	
10. Water should not be visually detectable in solvent exiting the water separator.	o This solvent is normally returned to the degreaser sump, or if so equipped, to the warm rinse tank. This solvent should be clear.	
11. Permanent, conspicuous label, summarizing operating procedures #1 to #6 above.	o Confirm the presence of this label.	

3.4.2 Record Review

Determining compliance of open top vapor degreasers through field inspections and monitoring is expensive and time consuming due to the large number of degreasers in use. It requires a great deal of manpower and tends to limit the number of sources that can be reviewed in a given year. The review of company-furnished records through questionnaires or letter requests may provide a viable alternative to field inspections and source monitoring activities for compliance determination. At minimum, this approach should be considered as a screening tool to identify candidate sources for comprehensive field inspections, thereby increasing the effectiveness of the available resources.

This discussion outlines several procedures that may be used when implementing a record review. Information will be required from the plant concerning the design and operation and maintenance of the equipment.

3.4.2.1 Review of Design, Operation, and Maintenance Data

The first requirement of this procedure is the development of standard questionnaires that can be sent out as part of a Section 114 request to the applicable sources. The type of information required is similar to what is identified on the inspection forms illustrated in Figure 3-12. It is important that the source understand what is being requested because the entire process of making compliance judgments using this procedure is highly dependent on the reliability of the information being furnished.

An example questionnaire is provided as Figure 3-13 and should be used as a guide only. It is suggested that the agency develop its own form which is specific to their program. For example, a screening program designed to identify major emitters may only require key data, while a more extensive request is necessary if compliance determinations are to be attempted. Three types of data are suggested for review: control equipment information, operational information, and maintenance records. The design data should be readily available, while operational and maintenance may require the source to create a special logging system in order to comply with the agency's request.

Criteria for review of the data should be established prior to finalizing the questionnaire. Obviously the criteria will address the overall objectives of the review program (e.g., screening program or compliance determination). In general, however, the design data should be compared to the original construction permit and design specifications and be at least as stringent as RACT.

FIGURE 3-13

<u>U.S. ENVIRONMENTAL PROTECTION AGENCY</u> <u>OPEN TOP VAPOR</u> <u>DEGREASER SUMMARY</u> <u>ONE COPY OF THIS FORM MUST BE FILLED OUT FOR EACH DEGREASER</u>														
1. BUSINESS LICENSE NAME OF CORPORATION, COMPANY, OR INDIVIDUAL OWNER OR GOVERNMENTAL AGENCY:														
2a. MAILING ADDRESS:	2b. PLANT ADDRESS WHERE THIS DEGREASER IS LOCATED:													
3. SOURCE NO. (PERMIT NUMBER, NEDS ID, ETC.):														
4. DEGREASER MANUFACTURER: _____ MODEL NO. _____ SERIAL NO. _____ INSIDE DIMENSIONS OF TANK (FT.): _____ WIDE X _____ LONG X _____ DEEP CONVEYORIZED: YES ☐ NO ☐ IF YES, GIVE CONVEYOR SPEED: _____ fpm TYPE OF DEGREASING: COLD SOLVENT CLEANING ☐ VAPOR DEGREASING ☐														
5. TYPE OF VAPOR LEVEL CONTROLS: THERMOSTAT ☐ CONDENSING COIL ☐ CHILLED WATER OR REFRIGERANT ☐ NONE ☐														
6. METHOD OF HEATING DEGREASER: GAS ☐ ELECTRIC ☐ STEAM ☐ Btu/hr. _____ OR KW _____														
7. CLEANING ACTION: SONIC ☐ IMMERSION IN LIQUID ☐ MECHANICAL MIXING ☐ VAPOR CONDENSATION ☐ SPRAY ☐ SPRAY PUMP H.P. _____ OTHER ☐														
8. TANK COVER: AUTOMATIC COVER ☐ MANUAL COVER ☐ NO COVER ☐ TANK COVERED WHEN NOT IN USE: YES ☐ NO ☐														
9. QUANTITY OF SOLVENTS USED: (Do not include quantities of used solvent sent back to supplier.) <table style="width: 100%; border: none;"> <tr> <td style="width: 40%;">a. CARBON TETRACHLORIDE</td> <td style="width: 60%;">_____ 55-GALLON DRUMS PER MONTH</td> </tr> <tr> <td>b. PERCHLOROETHYLENE</td> <td>_____ 55-GALLON DRUMS PER MONTH</td> </tr> <tr> <td>c. METHYLENE CHLORIDE</td> <td>_____ 55-GALLON DRUMS PER MONTH</td> </tr> <tr> <td>d. 1,1,1 -TRICHLOROETHANE</td> <td>_____ 55-GALLON DRUMS PER MONTH</td> </tr> <tr> <td>e. TRICHLOROETHYLENE</td> <td>_____ 55-GALLON DRUMS PER MONTH</td> </tr> <tr> <td>f. OTHER (IDENTIFY)</td> <td>_____ 55-GALLON DRUMS PER MONTH</td> </tr> </table>			a. CARBON TETRACHLORIDE	_____ 55-GALLON DRUMS PER MONTH	b. PERCHLOROETHYLENE	_____ 55-GALLON DRUMS PER MONTH	c. METHYLENE CHLORIDE	_____ 55-GALLON DRUMS PER MONTH	d. 1,1,1 -TRICHLOROETHANE	_____ 55-GALLON DRUMS PER MONTH	e. TRICHLOROETHYLENE	_____ 55-GALLON DRUMS PER MONTH	f. OTHER (IDENTIFY)	_____ 55-GALLON DRUMS PER MONTH
a. CARBON TETRACHLORIDE	_____ 55-GALLON DRUMS PER MONTH													
b. PERCHLOROETHYLENE	_____ 55-GALLON DRUMS PER MONTH													
c. METHYLENE CHLORIDE	_____ 55-GALLON DRUMS PER MONTH													
d. 1,1,1 -TRICHLOROETHANE	_____ 55-GALLON DRUMS PER MONTH													
e. TRICHLOROETHYLENE	_____ 55-GALLON DRUMS PER MONTH													
f. OTHER (IDENTIFY)	_____ 55-GALLON DRUMS PER MONTH													
10. OPERATING SCHEDULE: HOURS /DAY _____ DAYS/WEEK _____ WEEKS/YEAR _____														
11. DESCRIBE METHOD FOR DISPOSING OF SPENT SOLVENT:														

This would include such items as exhaust ventilation rates, types of safety switches, and cover design. Operational information should be compared to operating permits and operational specifications defined as RACT in the CTG. These parameters would include the use of powered or unpowered covers, the quantity and type of parts being cleaned, the method of waste solvent disposal, and the actual ventilation rates. Maintenance records should include repair or replacement records, recalibration schedule of temperature sensors, and some statement as to the general condition of the equipment.

3.4.2.2 Review Waste Solvent Disposal Procedures

A description of waste solvent disposal methods used by the source must be requested in the questionnaire initiated by the agency (example shown in Figure 3-13). A comparison should be made with the RACT operating requirements ("not greater than 20 percent can evaporate into the atmosphere"), and other acceptable practices which are readily available.

On larger open top vapor degreasers where greater quantities of solvent are used, it becomes economical to install a solvent distillation still for solvent reclamation. On installations of this type, both the sludge and solvent are pumped to the solvent still where the solvent is reclaimed. The liquid is heated to its vaporization temperature and the resulting vapors flow into a chilled condensing chamber where the vapors condense back to liquid. The liquid is then circulated back to the degreaser for further use. In this type of operation, only make-up liquid solvent is added, as needed. If properly designed and operated, the still should produce a sludge that contains less than 20% solvent by weight. Disposal of the sludge may be subject to hazardous waste disposal regulations. EPA has proposed regulations governing the disposal of such material in the Federal Register at 43FR58946 (December 18, 1978).

There are alternative approaches to an inhouse still, such as service contracts with outside agents which may be more attractive to the source and will also meet the RACT requirements.

CHAPTER 4

CONVEYORIZED DEGREASERS

4.1 PROCESS DESCRIPTION

4.1.1 Unit Operation

Conveyor operated solvent degreasers provide an efficient and economical method for preparing clean, dry articles for subsequent finishing or fabricating. There are several types of conveyORIZED degreasers and each can operate with either cold or vaporized solvents. The basic steps found in the typical conveyORIZED vapor degreaser include a vapor rinse upon entry to the degreaser vapor space section, liquid immersion, liquid spray, vapor rinse, and, finally, a slow withdrawal through a cold air space drying area.

A nonflammable solvent contained in the lower area of the degreaser, referred to as the boiling sump, is boiled to produce a vapor zone, the height of which is controlled by cooling coils installed above the vapor zone. The "cold work" introduced into the vapor space of the degreaser must be at a temperature lower than the vapor zone, in order to cause the solvent vapors to condense on the work surfaces and flush the oil and other foreign matter off with the liquid condensate. The removed material accumulates in the boiling sump and only the pure vapor comes in contact with the work load. Vapor flushing is followed by pure solvent spray and/or liquid immersion. The cool, pure solvent reduces the temperature of the work surface below the vapor temperature, producing a second vapor condensation flushing action on the work surfaces. When the work pieces are removed from the vapor zone, they should be clean, dry, and ready for further processing.

A well-operated conveyORIZED vapor degreaser should provide the required cleansing action and confine the solvent and solvent vapors, thereby maintaining a healthful working environment.

4.1.2 Types of ConveyORIZED Degreasers

ConveyORIZED degreasers are generally large, automatic units designed to handle a high volume of work in either a straight-through process or a return type process in which the work pieces enter and leave the degreaser unit from the same end. Their use minimizes the human element and produces consistently high quality cleaning with minimum solvent losses. As indicated earlier, there are several basic designs which are termed conveyORIZED degreasers: gyro, vibra, monorail, cross-rod, mesh belt and strip cleaners. Figures 4-1 to 4-4 present a sketch of each design (with the excep-

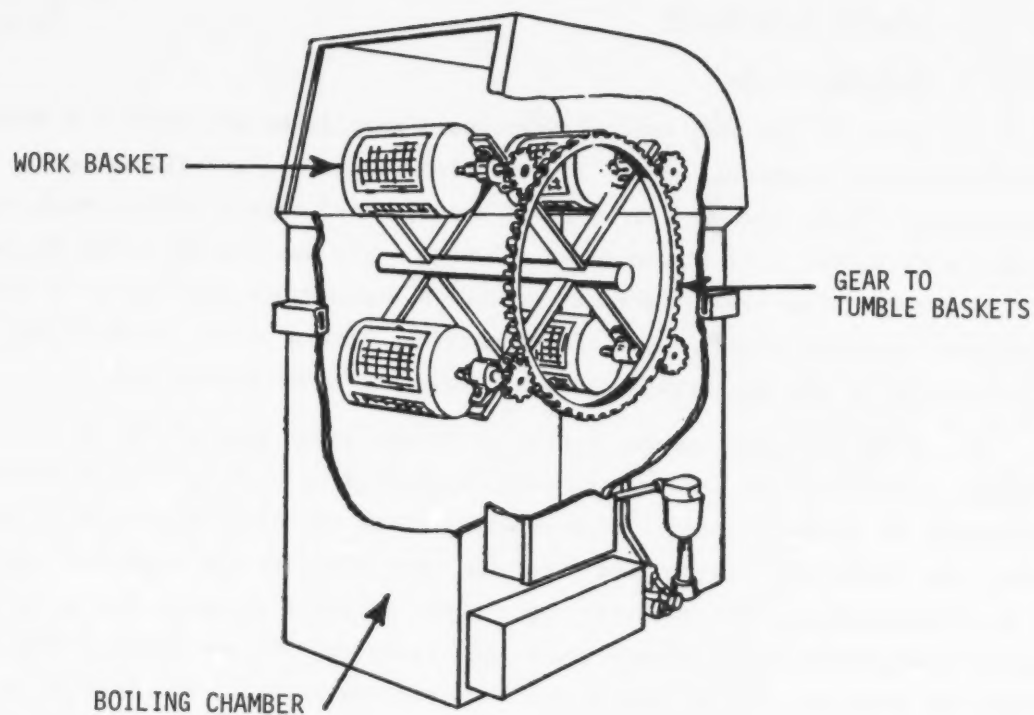


Figure 4-1a. Gyro Degreaser

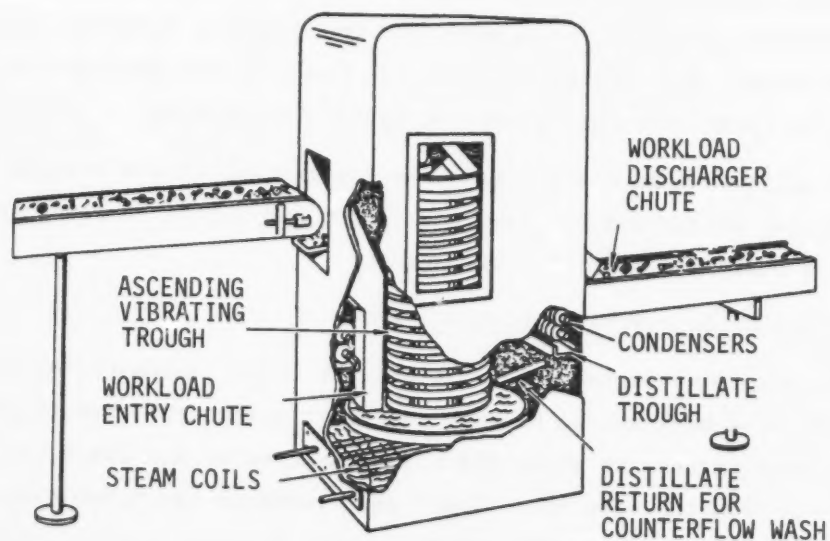


Figure 4-1b. Vibra Degreaser

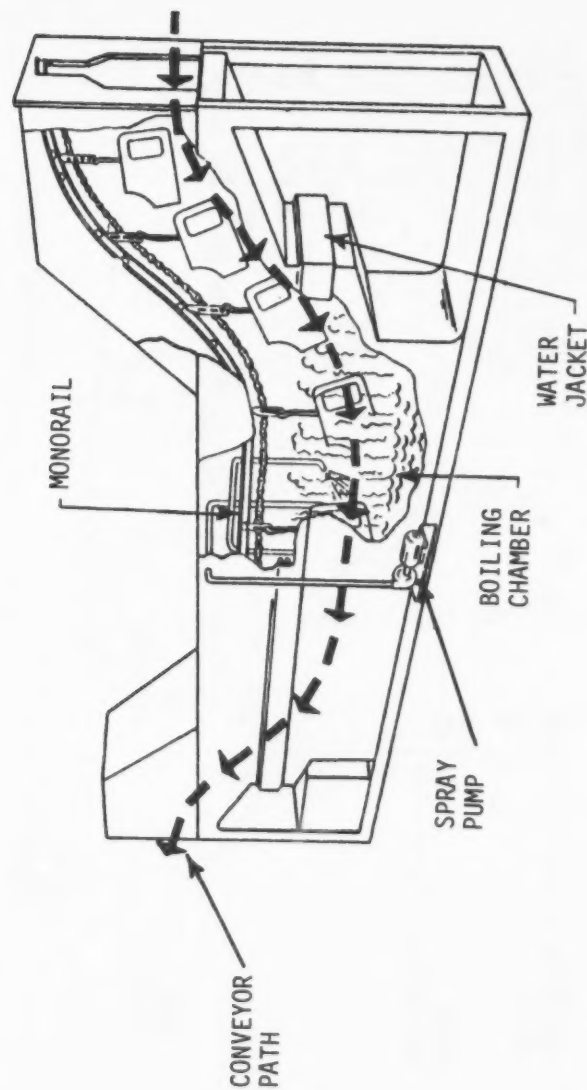


Figure 4-2. Monorail Degreaser

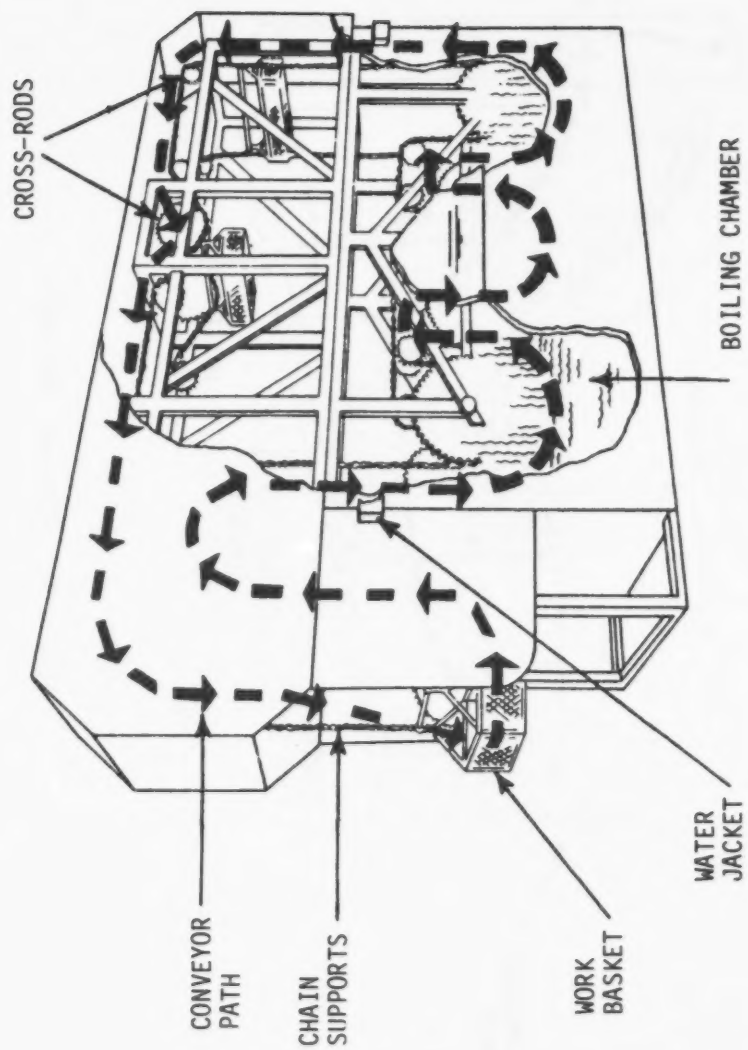


Figure 4-3. Cross-Rod Degreaser

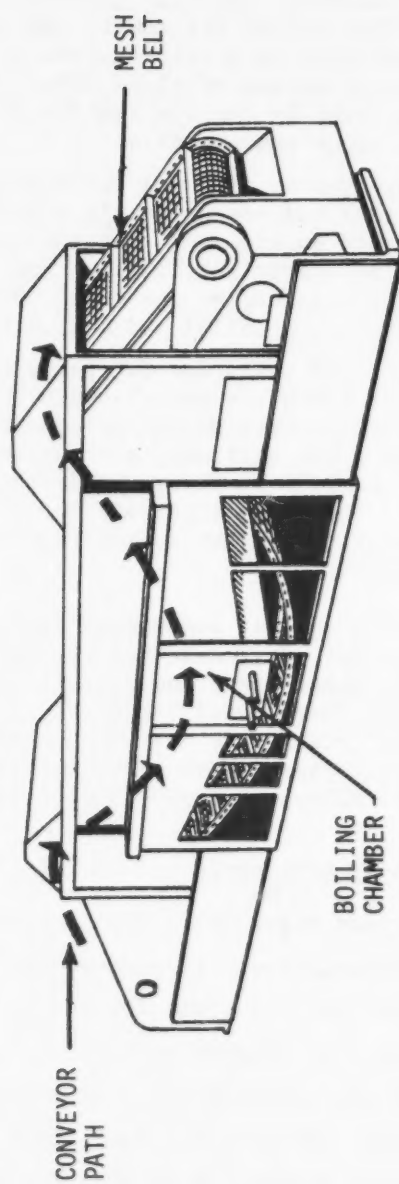


Figure 4-4. Mesh Belt Conveyorized Degreaser

tion of the strip cleaner type). A brief discussion of the rationale for each system follows:

- o Gyro (ferris wheel) type degreasers permit the operator to load and unload the baskets from one work station. The design is similar to the cross-rod degreaser. It is one of the smallest conveyorized degreasers available.
- o Vibra type degreasers are used for high production rate applications where the work pieces are small. The work piece is dipped into solvent, and rises on a spiral vibrating elevator through a counter-flow rinsing action of clean solvent vapor. Cleaning action is accomplished by the combination of vibration, solvent dip, and solvent vapor condensation.
- o Monorail conveyor systems are used for high production of standardized work pieces and are generally found in facilities that use monorail systems to transport materials within the plant. The monorail can be a straight through type, carrying parts in one side and out the other, or can turn 180° and exit the material through a duct that is parallel and adjacent to the entrance.
- o Cross-rod conveyorized units are generally used for processing small or irregular parts. A rod placed between two power-driven chains carries parts within suspended pendant baskets or perforated cylinders. The cylinders are rotated to provide the tumbling action required to clean and drain the crevices in the work pieces. The pendant baskets do not rotate and are used to carry small parts that do not require this action for cleaning and draining.
- o Mesh belt and strip cleaner degreasers are similar in design; however, the mesh belt degreaser carries the material to be cleaned while the other draws the material through. The latter design is used for sheet metal products. A continuous strip of material is drawn through the unit for cleaning prior to coating or fabrication processes. Mesh belt degreasers are used for smaller parts and allow for rapid loading and unloading of material.

4.1.3 Operation of Degreaser Components

Continuous conveyorized degreaser systems are straight forward in design. Although there are several types of conveyorized degreasers, they share common design characteristics. A typical unit, shown in Figure 4-5, consists of several components; a conveyor work piece transfer system to carry the work pieces through the degreaser, a bottom sludge sump, a solvent boiling sump with heating coils, and a vapor space above the boiling sump. Over the solvent vapor space and around the inner-periphery of the degreaser housing are cooling coils designed to maintain a temperature that will condense the vapors. Upon return to a liquid state, the solvent flows down to the boiling sump. The freeboard area above the primary condensing coils is designed to be of sufficient height to retard convection and diffusion losses

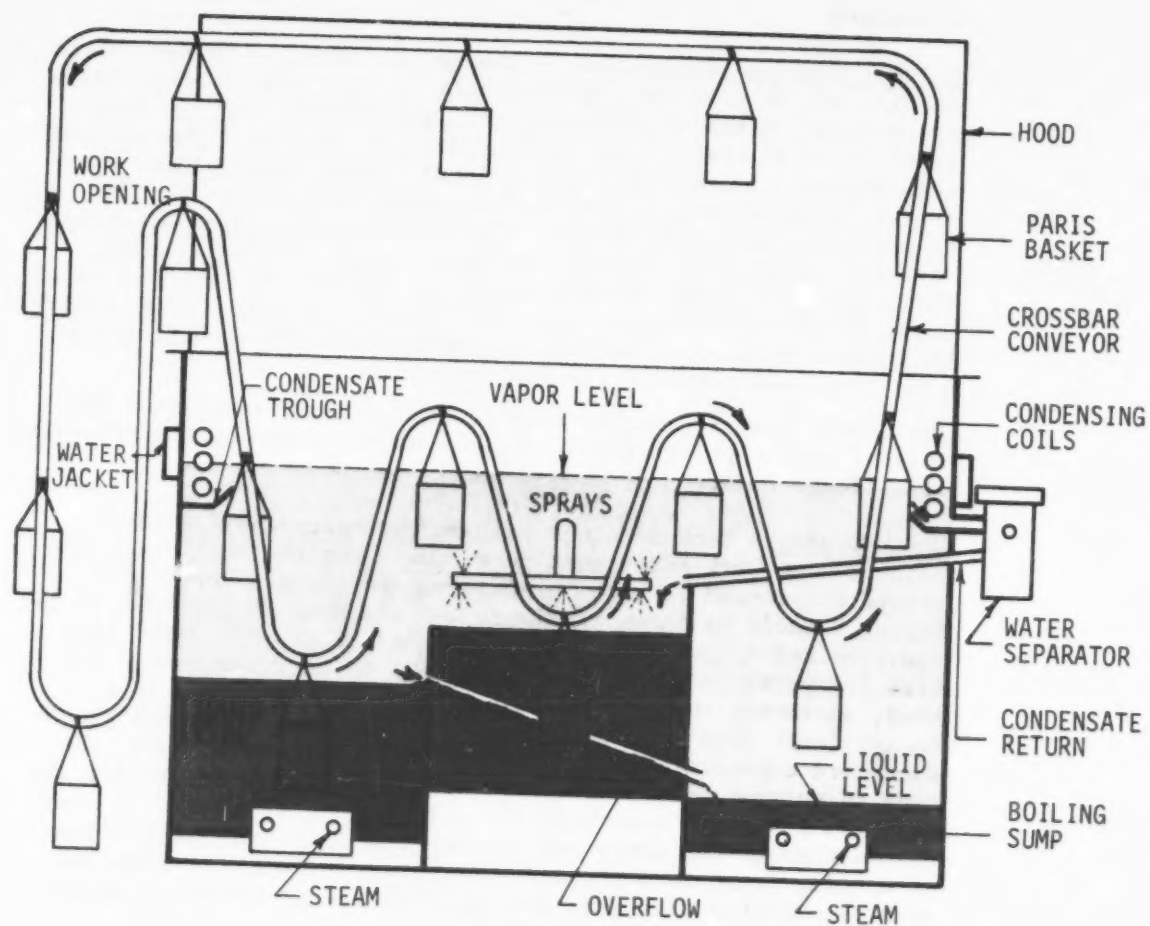


Figure 4-5. Liquid-Liquid-Vapor Cross-Rod Degreaser

to the atmosphere. Brief descriptions of the primary components are provided to familiarize the inspector with their operation.

- o Hood and Exhaust System - Unlike cold cleaners or open top cleaners, conveyorized degreasers do not require access to the product for manual handling. Therefore, they are generally enclosed units with a hood and exhaust system. The ventilation rate is established at a level sufficient to remove vapors from the enclosures; however, excessive rates may induce greater emissions.
- o Solvent Sump and Sludge Sump - The solvent sump is in the bottom section of the conveyorized degreaser and includes heating coils for vaporizing the liquid solvents. The solvent sump is also referred to as the solvent boiling area or chamber. The solvent sump includes solvent storage, a liquid level sight glass, heating coils and elements, sump safety thermostat controls, and an automatic shut-down switch. The primary adjustment affecting the bath evaporation rate is the heating and cooling balance. The heating rate must be sufficient to maintain the desired vapor level as cold parts enter the vapor zone. The vapor level control thermostat will sense hot vapors rising above the design operating level and turn off the sump heater.

The sludge sump is usually located in the lower section of the solvent sump. It generally contains either a cleanout drain valve or a cleanout door.
- o Work Opening - Work openings include the entry and discharge points. The work entry must be adequate for the work being processed but should be kept to a minimum to control vapor loss. Drying tunnels as shown in Figure 4-6 are used at the exit of the conveyorized degreaser, and are designed to provide additional time for parts to dry. A drying tunnel is an extension of the hood, enclosing the exiting conveyor for some distance (i.e. 2 to 10+ feet) from the degreaser. Its length and physical dimensions are dependent on the size of the part to be cleaned, the type of solvent and the required residence time to fully dry the individual parts. Even when the unit is controlled and no work passes through the entry and discharge ports, every square foot of opening presents a potential for vapor losses. In some instances, additional covers are employed during shut-down hours to prevent unnecessary emissions.
- o Conveyor System - Although the conveyor configuration varies for each type degreaser included in this group, the design concept is similar. Conveyors are designed to carry the cold part into the vapor chamber and out the other end. The product is generally suspended by hooks or carried in baskets which are attached to the conveyor. The mechanism for transporting material in the vibra type conveyor is slightly different; a vibrating tray is employed to move the material. The rate of movement is critical for sufficient contact and drying time; however, it also impacts on the degree of vapor loss to the surrounding area. In addition to the rate, the quantity of material being processed is another consideration. Too large a load may cool down and collapse the

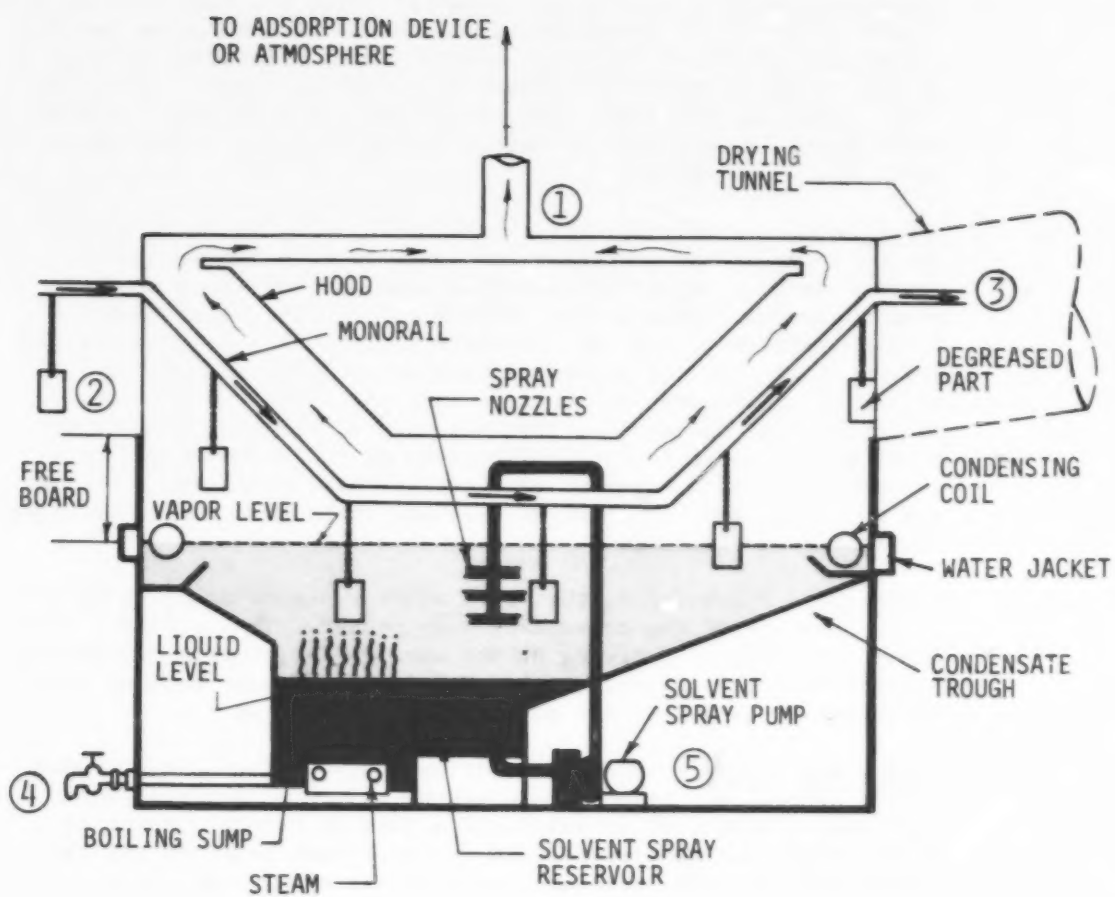


Figure 4-6. Typical Emission Points

vapor zone.

The load size is also dependent on the geometry of pieces being cleaned because greater quantities of crevices and surface areas will require more time for drying. (Rotating baskets would normally be used to turn the product around and dislodge some of the trapped liquid solvent.)

- o Condensing Coils - Condensing (cooling) coils are installed on the inside edges of the conveyorized degreaser. The coils define the vapor/air interface. They are usually coils consisting of four or more pipe coils stacked one above the other and located directly over a condensate trough. The condensing coils include a temperature gauge, a temperature control thermostat, and a high temperature shut-down switch.
- o Water Jacket- A water jacket, where applicable, is installed on the exterior of the degreaser and consists of a box section to contain cooling water circulating around the degreaser in the same approximate area as the cooling coils. The water jacket is also referred to as the freeboard cooler. Its function is to prevent convection of solvent vapors up hot degreaser walls. In addition, it reduces "sidewall radiation", which can increase air turbulence and thus disturb the cold air blanket in the freeboard area. Water jackets and condensing coils should not be confused with each other or with refrigerated chillers. Chillers are sometimes used in addition to these units in order to increase vapor control efficiency.
- o Freeboard - Freeboard is that area above the cooling coils extending to the top of the conveyorized degreaser. The freeboard zone permits drainage and drying of the work pieces, thereby minimizing solvent loss and air pollution. The freeboard zone reduces vapor disturbances caused by air motion in the work area.
- o Piping and Sprays - There is a minimum amount of piping included in the degreaser. Leaks should not be tolerated because they represent a source of emission and a loss of valuable material. Drain valves are generally found at the lowest point in the tank. Piping that is under pressure, such as the spray line, is a potential source of leaks. Sprays should be operated within the vapor zone so as to not disturb the air/vapor interface. Some designs spray the material in a contained chamber within the degreaser. A spray safety switch is generally provided to shut off the spray pump when the vapor level drops below the design level.
- o Water Separator - Water enters a degreaser from several sources, i.e., condensation of atmospheric moisture on condenser coils, moisture on work pieces being processed, and steam or cooling water leaks. Water forms a low boiling azeotrope with the solvent and is vaporized. Most degreasers are equipped with a water separator because uncontrolled water causes corrosion, shortens solvent life, and increases the vaporization rate of solvent. The condensed solvent-water mixture drops into the condensate trough below the condenser coils and flows by gravity to the separator.

- o Waste Solvent Disposal - Although there are several methods for disposing of waste solvent, most current practices of dumping are unacceptable. The preferred treatment would be the use of reclamation services to be accomplished internally or by outside vendors. Where applicable, direct incineration and chemical landfills are also viable alternatives. Reclamation using solvent recovery stills has the greatest appeal for large users because it represents a savings of valuable material.

4.2 ATMOSPHERIC EMISSIONS

4.2.1 Emission Points

There are several locations in a conveyorized degreaser that may allow organic liquid or vapor to escape to the atmosphere. These are identified in Figure 4-6. In general, conveyorized degreasers are hooded and vented to the outside. Therefore, an emission point is the vent line and subsequent exhaust. In most instances, a control device such as a carbon adsorption system is placed in the line to remove organic vapors. Although constant ventilation of the hood should create a negative pressure and prevent vapors from escaping from the work openings, ventilation rates are kept to a minimum level (< 65 cfm per ft² of degreaser opening) to prevent disruption of the vapor-level boundary and corresponding increased emissions. However, in minimizing the ventilation rate, the opportunity for vapors to escape from the work openings increases at the inlet (Location 2) and exit (Location 3) of the degreaser. In addition, at the exit of the unit the cleaned material may be carrying out liquid organic material which condensed on its surface but did not totally dry or drip off while in the degreaser.

As the solvent material is spent and itself becomes contaminated with impurities, its usefulness decreases. Most conveyorized degreasers are designed to distill and recycle this material on a continuous basis through the use of external stills. However, these stills will eventually accumulate wastes and, depending on the method of disposal, waste solvents may enter the atmosphere at this point.

Fugitive emissions can occur at any of the piping connections or sump seals that may have loosened or become worn because of continuous operation. Where good housekeeping practices are followed, these emission points are eliminated fairly quickly because they are detectable by visual observation, represent a correctable loss of valuable material, and create a potentially unhealthy work environment.

4.2.2 Parameters Affecting Rate of VOC Emissions

The rate of vapor emissions emanating from the various points previously discussed is dependent on a variety of operating and design parameters. Emissions can be minimized by attempting to achieve certain optimum conditions; however, it is important to understand the cause and effect relationship. The following parameters significantly affect VOC emissions from conveyORIZED degreasers:

- o Drafts - A fan or other air-moving devices located in the work area near the degreaser can cause a draft to enter the freeboard area of the degreaser housing, thereby upsetting the balance of the air/vapor interface.
- o Size of Work Opening - Although conveyORIZED degreasers are generally covered, the size of the opening allowing work loads to enter and exit should be kept to a minimum to reduce the opportunity for vapors to escape. The term "average silhouette clearance" is used to define the distance from the edge of the degreaser opening to the part or the basket or cage conveying the part. Where hoods are exhausted, the smaller the opening the greater the capture velocity of the room air traveling through the area and the greater the control of vapors escaping at this point.
- o Exhaust Rate - The greater the exhaust rate, the greater the control of vapor escaping from the work openings; however, an excessive exhaust rate also produces greater emissions because it disturbs the vapor and air interface within the degreaser, thereby exhausting high concentrations of organic vapors into the exhaust gas stream. To achieve both goals the exhaust rate should not exceed $20 \text{ m}^3/\text{min}$ per m^2 (65 cfm per ft^2) of degreaser opening.
- o Conveyor Speed - As the conveyor speed increases, emissions increase. Increased speeds represent less time for the material to dry. Therefore, evaporation of the liquid droplets that originally condensed on the cold material will take place outside the hooded portion of the degreaser and will increase emissions. Too rapid a conveyor speed may also induce drafts that will create vapor loss at the outlet work opening. Conveyor speeds must be maintained below 3.3 m/min (11 ft/min) to minimize losses.
- o Type and Magnitude of Load - Atmospheric emissions increase when the parts being processed in the conveyORIZED degreaser contain numerous pockets or liquid traps that allow liquids to be carried from the degreaser chamber. Liquid trapped in pockets can be removed by placing the working pieces in baskets which are rotated and tumbled as they move through the degreaser so that they drain liquid solvent back to the sump. Increases in the magnitude of the work load will cool the vapor area. A massive load may cause a collapse of the vapor space and increase emissions. When the vapor space collapses two situations arise, (1) the vapor/air

layers mix and organic vapors escape and (2) the working pieces spend less time within the collapsed vapor space and therefore have less time to evaporate the condensed solvent, resulting in greater carry out and subsequent emissions.

- o Solvent Heat Input - Once the solvent's boiling temperature has been achieved, increasing the heat input to the solvent will increase the rate of solvent vaporization. If continued, the cool air blanket generated by the condenser coils may not be sufficient to retain the increased vapors and breakthrough could occur, resulting in greater emissions.
- o Temperature and Flow Rate of the Condensing Coils - The function of a condensing coil is to limit the upper level of the vapor zone. A condenser consisting of a coil of pipe through which cooling water flows, creates a blanket of cool air. The flow rate and temperature of the water affect the efficiency of a given set of coils with a given heat input rate. Increasing flow increases efficiency. Decreasing the temperature of the water will also increase the efficiency of the coils in supporting the vapor layer.

4.3

EMISSION CONTROL METHODS

The EPA Control Technology Guideline (CTG) document for solvent metal cleaning identifies a number of control strategies for reducing volatile organic emissions from conveyORIZED degreasing operation. These form the basis of defining RACT for the conveyORIZED degreaser and should therefore be the focal point of a field inspection. The CTG document suggests two levels of control. EPA's policy regarding the application of these control levels is discussed in Chapter 1. Level A represents a relatively low efficiency system, estimated at 25 ± 5 percent. Level B, consisting of Level A plus additional requirements represents a higher efficiency system, estimated at 60 ± 10 percent. The following discussion will address these and other control measures found in the CTG document. However, the organization is slightly different. It is divided into three areas: process equipment design, operating requirements, and control equipment requirements. In addition, a second series of suggested controls is offered which do not appear in the CTG document. These controls should be considered by the inspector as additional means of reducing emissions.

It should be noted that a given control strategy will not provide equal results for similar degreasers or degreasers used in different applications. Therefore, each degreaser should be evaluated individually.

4.3.1 RACT Controls

o Process Equipment Design

- oo Minimum entrance and exit openings should be provided by silhouetting the work load. The average silhouette clearance (distance between the edge of the openings and the part) should be < 10 percent of the opening width.
- oo Safety switches should be included in the design to prevent emissions during malfunctions and abnormal operation.
 - a. Condenser flow switch and thermostat shut off sump heat if coolant is either not circulating or becomes too hot.
 - b. Spray safety switch shuts off spray pump or conveyor if vapor level drops excessively.
 - c. Vapor level control thermostat shuts off sump heat when vapor level rises too high.

- o Operating Requirements
 - oo Conveyor speed should be < 3.3 m/min (11 ft/min) to minimize solvent carry-out emissions.
 - oo Exhaust ventilation should not exceed $20 \text{ m}^3/\text{min}$ per m^2 (65 cfm per ft^2) of degreaser opening unless necessary to meet Occupational Safety and Health Administration (OSHA) requirements or the degreaser is vented to a carbon adsorber.
 - oo Work place fans should not be used near the degreaser opening because they will induce mixing of the air/vapor layer, thereby increasing emissions.
 - oo Solvent leaks should be repaired immediately, or the degreaser should be shut down, until repairs can be made.
 - oo Water should not be visibly detected in the solvent exiting the water separator. For chlorinated solvents, water contributes to vapor loss because the mixture of water and solvent has a lower density than that of dry solvent. In addition, water contributes to corrosion and creates a low boiling azeotrope with the solvent in the boiling sump.
 - oo Down-time covers must be placed over entrances and exits of conveyorized degreasers immediately after the conveyor and exhaust are shut down and removed just before they are started.
 - oo Disposal or transfer of waste solvents should be performed in a manner that will not allow greater than 20 percent of the waste (by weight) to evaporate to the atmosphere. Waste solvents should be stored in covered containers.
 - oo Racking parts to allow maximum drainage should be implemented to minimize carry-out emissions.
- o Control Equipment Requirements
 - oo Rotating baskets, trays, etc., and/or a drying tunnel should be provided to prevent solvent drag-out. Such carry-out is most likely to occur from solvent hold up in recesses or pockets in the work being degreased.
 - oo Covers must be provided for the entrance and exit in order to close these openings immediately after shutting down the degreaser. These covers should close off at least 80 to 90 percent of the opening to effectively prevent solvent emissions.

- oo Refrigerated chillers can be used to control the upper limit of the vapor zone; or carbon adsorption systems should be used to control emissions in the exhaust line of the degreaser. The ventilation rate (when down-time covers are open) should be $\geq 15 \text{ m}^3/\text{min}$ per m^2 (50 cfm/ft²) of air /vapor area for adsorbers.
- oo The exhaust gas from the adsorption system must contain < 25 ppm solvent by volume averaged over a complete adsorption cycle.
- oo Alternate control systems may be used if they demonstrate control efficiencies equal to or greater than the refrigerated chiller or carbon adsorption units.

4.3.2 Other Controls

Several control techniques are discussed in the literature that deserve mention although they are not recommended by EPA as RACT requirements.

- o The unit is capable of being hooded or covered without affecting its operation. The enclosure of a degreaser diminishes solvent losses from the system that result from the movement of air within the plant.
- o Sprays should be designed or adjusted so they do not cause turbulence at the air/vapor interface; spraying must be conducted below the vapor line. Spray pressure should be the minimum necessary for adequate cleansing.
- o Overloading work baskets may reduce the vapor temperature and collapse the vapor zone, thereby increasing the air/vapor mixing and subsequent emissions. This situation can be avoided by following equipment specifications for the allowable work load as determined by a system heat balance.
- o A solvent reclaimer-still to recycle and return a purified solvent to the solvent sump. This will tend to stabilize vaporization rates and eliminate emission due to improper waste disposal methods.
- o Where work being degreased contains acidic cutting oils or other acidic products, acid acceptance and pH determination should be made to determine the quality of the solvent.
- o Absorbent materials such as wood and fabric materials should not be degreased or used in the basket construction.
- o A "good housekeeping" and maintenance program should be in effect. Clean out doors, line connections, pumps, water separator, etc., should be checked frequently.
- o For large users of solvent, bulk storage may prove more economical than purchases by individual drums. Where bulk storage is used, a submerged fill pipe from the top of the tank should be included in the design of the storage tank. Alternate controls such as a return vent line to a recovery still should be investigated.

4.4 INSPECTION PROCEDURES

This section will discuss two types of inspections: (1) field review and (2) office reviews. Source sampling, still another form of inspection, will be discussed in the next chapter.

Field investigations range from brief plant visits to thorough inspections that produce a complete data base for enforcement proceedings. Office reviews rely on the source to furnish information. This approach may require less time and manpower but the resulting data base is generally less complete. Office reviews, however, provide a useful screening tool where the number of potential violators is large.

4.4.1 Field Inspections

After becoming familiar with the plant and its facilities the inspector should request that the appropriate company official provide information from company records that will allow the inspector to complete the worksheets shown in Figure 4-7. The data may also be available from permit applications. The worksheet divides the required data into two categories: operating requirements, and control equipment. It also provides the RACT requirements for each category with suggested inspection procedures and guidelines. With such information, comparisons can be made with past conditions, and with operations at the time of the inspection.

Generally, the inspector would next request the company's assistance in conducting a full inspection of the facility in order to verify actual operating conditions. This inspection may take several hours depending on the number and types of conveyorized degreasers. Figures 4-8 and 4-9 present a photo and a schematic of a crossroad degreaser with a rotating basket which identify general components of a conveyorized degreaser.

All field data, such as temperature of the solvent, conveyor speed, exhaust flow rate, silhouette clearance, etc., should be seen and verified. For equipment that is operating, the inspector must be prepared to collect this data with his own resources. The inspector should concentrate on those parameters affecting emission rates and control procedures identified earlier in this chapter.

This information will be compared to the data given by the company official, and the total data base will be compared to the RACT requirements for design and operating conditions to determine if a violation exists. At that time, a reinspection date should be established if it is determined that the source is not in compliance.

**Figure 4-7. Example Worksheet for Field Inspection of
Conveyorized Degreasers**

1. BUSINESS LICENSE NAME OF CORPORATION, COMPANY, OR INDIVIDUAL OWNER OR GOVERNMENTAL AGENCY:		
2a. MAILING ADDRESS:	2b. PLANT ADDRESS WHERE THIS DEGREASER IS LOCATED:	
3. SOURCE NO. (PERMIT NUMBER, NEDS ID, ETC.)		
4. NAME AND TITLE OF COMPANY REPRESENTATIVE:		
5. TELEPHONE NO.:		
6. NAME OF OFFICIAL CONDUCTING INSPECTION:		
7. DEGREASER MANUFACTURER: _____ MODEL NO. _____ SERIAL NO. _____ INSIDE DIMENSIONS OF TANK (FT.): _____ WIDE X _____ LONG X _____ DEEP TYPE OF DEGREASING: COLD SOLVENT CLEANING ☐ VAPOR DEGREASING ☐ TYPE OF CONVEYOR _____		
8. TITLE AND CODE NUMBERS OF DRAWINGS, SPECIFICATIONS, STANDARDS, CODES, PROCEDURES AND DOCUMENTS USED WITH THE INSPECTION		
9. TYPE OF SOLVENT IN USE (SPECIFIC NAME AND MANUFACTURER):		
INSPECTION OBSERVATIONS		
RACT REQUIREMENTS	SUGGESTED INSPECTION PROCEDURE	FIELD OBSERVATIONS
CONTROL EQUIPMENT		
1. Safety Switches a. Condenser flow switch & thermostat	- o Confirm that the switch and thermostat have been installed. - o If available, check readings of flow and temperature indicators. For high boiling solvents, the temperature should be about 8° to 11°C (15° to 20°F) above dewpoint of surrounding atmosphere or 32° to 46°C (90° to 115°F). For low boiling solvents (methylene chloride and fluorocarbon 113) the exit temperature should be less than 29°C (85°F). Many installations may not have a temperature indicator at the cooling coil exit. A rough estimate of the temperature may be made if a bleed valve is available at the exit end of the coils. Bleed a sample of coolant into a small vessel and measure the temperature with a portable thermometer.	

FIGURE 4-7

(Continued)

FACT REQUIREMENTS	SUGGESTED INSPECTION PROCEDURE	FIELD OBSERVATIONS
1. (continued) b. Spray Safety Switch c. Vapor level control thermostat	- o If plant is agreeable, interrupt flow of coolant and determine if switch is tripped. - o Confirm that the switch has been installed. - o Confirm that vapor level control thermostat is located just above cooling coil or jacket. - o Suggested thermostat settings for four types of solvents: -Perchloroethylene 82°C (180°F) -Trichloroethylene - 68°C (155°F) -1,1,1-Trichloroethane 60°C (140°F) -Methylene Chloride 32°C (90°F) or about 6°C (10°F) lower than boiling point of solvent-water azeotrope - o Read temp. on indicators	
2. Minimized openings at entrance and exit of conveyor	o Determine with a tape measure that the average silhouette is less than 10 cm (4 in.) or less than 10 percent of the width of the opening.	
3. Drying tunnel or rotating baskets	o Observe whether the degreaser is equipped with either of these devices. Observe whether parts are wet or have liquid in crevices when exiting the degreaser.	
4. Refrigerated chiller	- o Observe indicated coolant temperature. - oo For subzero chillers the temperature should not exceed -25°C (-13°F). - oo For above freezing chillers the temperature should not exceed 5°C (40°F). - oo Do <u>not</u> attempt to extract a sample of coolant from a refrigerated chiller. - o Determine the cooling capacity from the design specifications.	

FIGURE 4-7

(Continued)

RACT REQUIREMENTS	SUGGESTED INSPECTION PROCEDURE	FIELD OBSERVATIONS
	- oo For subzero chillers the minimum cooling capacity should be as follows for each degreaser width: (The cooling units are Btu's per hour per foot of perimeter.) <3.5 ft - 200 >3.5 ft - 300 >6 ft - 400 >8 ft - 500 >10 ft - 600 - oo For above freezing chillers the cooling capacity should be at least 500 Btu/hr per foot of perimeter.	
5. Carbon adsorption system with ventilation $>15 \text{ m}^3/\text{min per m}^2$ (50 cfm/ft²) of air/vapor area.	- o Solvent odors should not be detectable on the roof downwind from the stack. - o Determine the air handling capacity of the fan, -or- - If sampling ports are available, the velocity of the exhaust gases may be measured with a swinging vane velocity meter. Also determine the cross-sectional area of the duct, then calculate the cfm. - o After the air volume is determined from either of the above methods, obtain the area of the air/vapor opening and calculate the cfm per square foot of opening. - o See the source testing chapter of this manual.	
<u>OPERATING REQUIREMENTS</u> 1. a. Exhaust ventilation should not exceed $20 \text{ m}^3/\text{min per m}^2$ (65 cfm per ft²) of degreaser open area unless necessary to meet OSHA requirements. (This ventilation rate is applicable if a carbon adsorber is not installed.) b. Work place fans should not be used near degreaser opening.	- o Determine the air handling capacity of the fan, -or- - If sampling ports are available, the velocity of the exhaust gases may be measured with a swinging vane velocity meter. Also determine the cross-sectional area of the duct, then calculate the cfm. - o After the air volume is determined from either of the above methods, obtain the area of the degreaser opening and calculate the cfm per square foot of degreaser opening. - o Note the location of ventilation fans near the degreaser.	

FIGURE 4-7

(Continued)

RACT REQUIREMENTS	SUGGESTED INSPECTION PROCEDURE	FIELD OBSERVATIONS
2. Water should not be visually detectable in solvent exiting the water separator.	o Observe any water present in the sight glass on the separator.	
3. Conveyor speed should not exceed 3.3 m/min. (11 ft/min).	o Check conveyor speed with stop watch.	
4. Rack parts for best drainage.	o Observe whether parts are racked in a manner that allows liquid solvent to collect in pockets and crevices.	
5. Repair solvent leaks immediately.	o Inspect for wetted areas around pump seals, sight glass, pipes, etc.	
6. Downtime covers	o If the unit is not in operation, observe whether they are in place.	
7. a. Do not dispose of waste solvent or transfer it to another party such that greater than 20 percent of the waste (by weight) can evaporate into atmosphere. b. Store water solvent only in covered containers.	o Determine if source has inhouse reclamation facilities (i.e. still) or a service contract with a solvent reclamation firm. o Confirm that storage is done with covered containers by visual inspection. o Check for container leakage.	

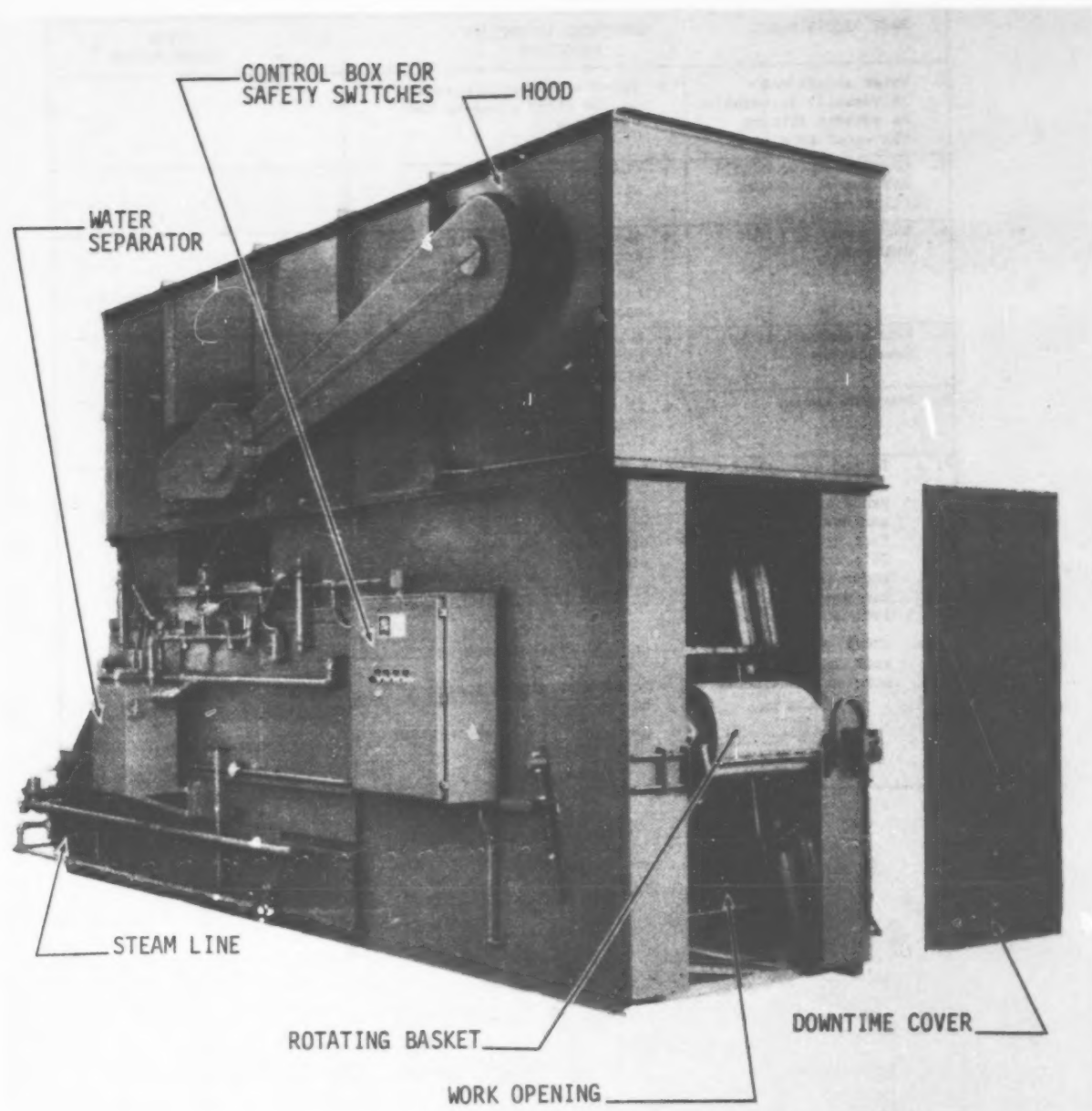


Figure 4-8. Cross Rod with Rotating Baskets

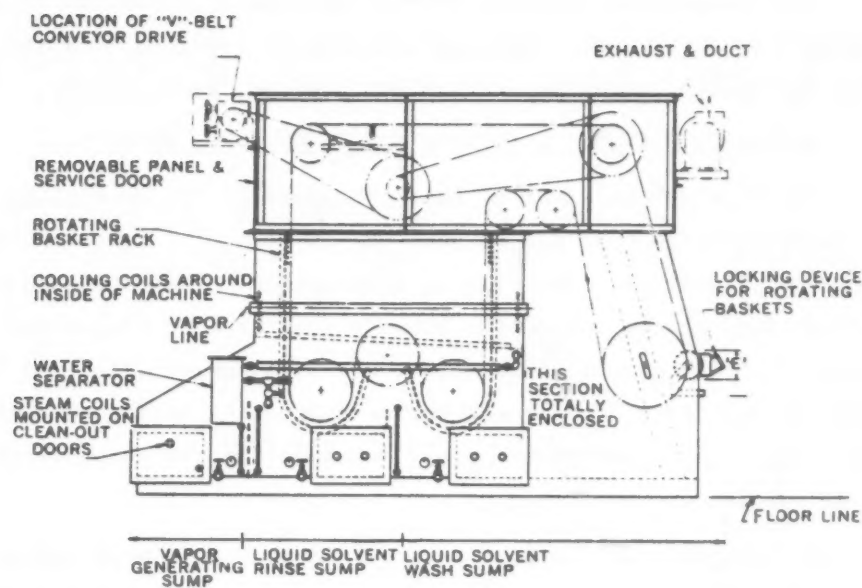


Figure 4-9. Cross Rod with Rotating Baskets (Sketch)

4.4.2 Record Review

Determining compliance of conveyORIZED degreasers through field inspections and monitoring is expensive and time consuming. It requires a great deal of manpower and tends to limit the number of sources that can be reviewed in a given year. The review of company-furnished records through questionnaires or letter requests may provide a viable alternative to field inspections and source monitoring activities for compliance determination. At minimum, this approach should be considered as a screening tool to identify candidate sources for comprehensive field inspections, thereby increasing the effectiveness of the available resources.

This discussion outlines several procedures which may be used when implementing a record review. Information will be required from the plant concerning the design, operation and maintenance of the equipment.

4.4.2.1 Review of Design, Operation, and Maintenance Data

The first requirement of this procedure is the development of standard questionnaires that can be sent out as part of a Section 114 request to the applicable sources. The type of information required is similar to what is identified on the inspection forms illustrated in Figure 4-7. It is important that the source understand what is being requested and that the request be realistic because the entire process of making compliance judgments using this procedure is highly dependent on the reliability of the information furnished.

An example questionnaire is provided as Figure 4-10 and should be used as a guide only. It is suggested that the agency develop its own form which would be specific to the program. For example, a screening program may only require key data, while a more extensive request is necessary if compliance determinations are to be attempted. Three types of data are suggested for review: design information, operational information, and maintenance records. The design data should be readily available, while operational and maintenance may require the source to create a special logging system in order to comply with the agency's request.

Figure 4-10. Questionnaire for Conveyorized Degreasers

1. BUSINESS LICENSE NAME OF CORPORATION, COMPANY, OR INDIVIDUAL OWNER OR GOVERNMENTAL AGENCY: _____	
2. a. MAILING ADDRESS: _____	2. b. PLANT ADDRESS WHERE THIS DEGREASER IS LOCATED: _____
3. SOURCE NO. (PERMIT NUMBER, NEDS ID, ETC.) _____	
4. NAME AND TITLE OF AUTHORIZED COMPANY REPRESENTATIVE FURNISHING DATA: _____ SIGNATURE: _____	
5. TELEPHONE NO.: _____	
6. DEGREASER MANUFACTURER: _____ MODEL NO. _____ SERIAL NO. _____ INSIDE DIMENSIONS OF TANK (FT.): _____ WIDE X _____ LONG X _____ DEEP CONVEYORIZED: YES ☐ NO ☐ IF YES, GIVE TYPE _____ TYPE OF DEGREASING: COLD SOLVENT CLEANING ☐ VAPOR DEGREASING ☐ WORK LOAD DESIGN SPECS _____	
7. CONTROL EQUIPMENT: NAME _____ TYPE _____ MODEL NO. _____ CFM _____ EFF. _____	
8. DRYING TUNNEL: YES ☐ NO ☐ TUMBLING OR ROTATING BASKETS: YES ☐ NO ☐ TANK COVERED WHEN NOT IN USE: YES ☐ NO ☐	
9. SAFETY SWITCHES: ☐ CONDENSER FLOW SWITCH AND THERMOSTAT ☐ SPRAY SAFETY SWITCH ☐ VAPOR LEVEL SAFETY SWITCH	
10. REFRIGERATED CHILLERS DESIGN TEMPERATURE FOR REFRIGERANT _____ °C or _____ °F	
11. DISPOSITION OF SPENT SOLVENT FROM DEGREASER _____ SLUDGE FROM STILL _____ SOLVENT FROM ADSORBER _____	
12. OPERATING PARAMETERS ACTUAL CONVEYOR SPEED _____ FT/MIN FLOW RATE OF EXHAUST GAS _____ CFM TEMPERATURE OF SOLVENT BATH _____ °C or _____ °F CHEMICAL NAME OF SOLVENT _____	

Figure 4-10. Questionnaire for Conveyorized Degreasers

1. BUSINESS LICENSE NAME OF CORPORATION, COMPANY, OR INDIVIDUAL OWNER OR GOVERNMENTAL AGENCY:	
2. a. MAILING ADDRESS:	2. b. PLANT ADDRESS WHERE THIS DEGREASER IS LOCATED:
3. SOURCE NO. (PERMIT NUMBER, NEDS ID, ETC.)	
4. NAME AND TITLE OF AUTHORIZED COMPANY REPRESENTATIVE FURNISHING DATA: SIGNATURE: _____	
5. TELEPHONE NO.:	
6. DEGREASER MANUFACTURER: _____ MODEL NO. _____ SERIAL NO. _____ INSIDE DIMENSIONS OF TANK (FT.): _____ WIDE X _____ LONG X _____ DEEP CONVEYORIZED: YES ☐ NO ☐ IF YES, GIVE TYPE _____ TYPE OF DEGREASING: COLD SOLVENT CLEANING ☐ VAPOR DEGREASING ☐ WORK LOAD DESIGN SPECS _____	
7. CONTROL EQUIPMENT: NAME _____ TYPE _____ MODEL NO. _____ CFM _____ EFF. _____	
8. DRYING TUNNEL: YES ☐ NO ☐ TUMBLING OR ROTATING BASKETS: YES ☐ NO ☐ TANK COVERED WHEN NOT IN USE: YES ☐ NO ☐	
9. SAFETY SWITCHES: ☐ CONDENSER FLOW SWITCH AND THERMOSTAT ☐ SPRAY SAFETY SWITCH ☐ VAPOR LEVEL SAFETY SWITCH	
10. REFRIGERATED CHILLERS DESIGN TEMPERATURE FOR REFRIGERANT _____ °C or _____ °F	
11. DISPOSITION OF SPENT SOLVENT FROM DEGREASER _____ SLUDGE FROM STILL _____ SOLVENT FROM ADSORBER _____	
12. OPERATING PARAMETERS ACTUAL CONVEYOR SPEED _____ FT/MIN FLOW RATE OF EXHAUST GAS _____ CFM TEMPERATURE OF SOLVENT BATH _____ °C or _____ °F CHEMICAL NAME OF SOLVENT _____	

Criteria for review of the data should be established prior to finalizing the questionnaire. Obviously the criteria will address the overall objectives of the review program (e.g., screening program or compliance determination). In general, however, the design data should be compared to the original construction permit and the design specifications and be at least as stringent as RACT. This review would include such items as exhaust ventilation rates, types of safety switches, design conveyor speed, and the availability of control equipment. Operational information should be compared to operating permits and operational specifications defined as RACT. These parameters would include the silhouette distance, the use of down-time covers, the quantity and type of parts being cleaned, the method of waste solvent disposal, and actual ventilation rates. Maintenance records should include repair or replacement records and some statement as to the general condition of the equipment.

4.4.2.2 Review Waste Solvent Disposal Procedures

A description of waste solvent disposal methods used by the source must be requested in the questionnaire initiated by the agency (example shown in Figure 4-10). A comparison should be made with the RACT operating requirements ("not greater than 20 percent can evaporate into the atmosphere"), and data on other acceptable practices which are readily available.

On conveyORIZED vapor degreasers where large quantities of solvent are used, it becomes economical to install a solvent distillation still for solvent reclamation. On installations of this type, both the sludge and solvent are pumped to the solvent still where the solvent is reclaimed. The liquid is heated to its vaporization temperature and the resulting vapors flow into a chilled condensing chamber where the vapors condense back to liquid. The liquid is then circulated back to the conveyORIZED vapor degreaser for further use. In this type of operation, only make-up liquid solvent is added, as needed. There are alternate approaches to an inhouse still, such as service contracts with outside agents which may be more attractive to the source and will also meet the RACT requirements.

The sludge remaining in the still along with water and spent unreclaimable solvent should be disposed of in accordance with the Resource Conservation and Recovery Act. Pursuant to this legislation EPA has proposed regulations for the disposal of hazardous wastes at 43FR58946 (December 18, 1975).

CHAPTER 5

EMISSION TESTING OF CARBON ADSORPTION SYSTEMS

5.1 INTRODUCTION

The compliance status of a carbon adsorption system cannot always be determined by a routine source inspection or by an engineering evaluation conducted in the office. For those cases where the compliance status is uncertain or where violations are anticipated, measurement of the solvent concentration in the effluent gases will be necessary to establish the compliance status. It would be ideal if there were an accurate, quick, easy, inexpensive compliance test method available for inspectors. Unfortunately, the present methods that are sufficiently accurate ($\pm 10\%$ or better) for compliance concentration measurements of halogenated organics are not particularly quick, easy, and inexpensive; and the methods that meet these latter requirements are not sufficiently accurate for exact compliance determinations. Because no single method currently exists that satisfies all the requirements of an ideal compliance test method, two methods have been selected. The first method is a screening method that is quick, easy, and relatively inexpensive. The second method is designed to provide the accuracy necessary for full fledged enforcement compliance actions. The screening method and the recommended reference method are presented in Section 5.2 and Section 5.3, respectively. In addition, a method is described in Section 5.4 for conducting a material balance so that emissions can be determined on a pounds per hour or pounds per day basis.

The screening procedure is designed to be quick, easy, and inexpensive. The primary objective is to provide an inspector with a method that can identify those sources that are well below the emission concentration limitation as well as those sources that are well above the limitation, while not adding significantly to the inspectors work load nor requiring a substantial investment in either personnel training or equipment. The screening method can be

used by an inspector during a routine source inspection, and will add only 15 to 30 minutes to the field inspection time. Personnel can be trained to use the method in 1 to 2 hours. Equipment for the screening method will cost from \$2,000 to \$4,000.

The screening method provides an instantaneous reading of apparent solvent concentration in the gases emitted from solvent adsorption systems. The instruments used cannot identify specific compounds, nor can they selectively measure individual compounds in a mixture of solvent vapors. They respond to practically all volatile organic compounds, although the magnitude of the response varies from compound to compound. For these reasons, the screening method cannot provide the quality of data necessary for an enforcement action. What the screening method can do, however, is indicate the apparent compliance status of sources, thereby significantly limiting the number of full compliance tests that must be conducted.

The EPA guideline document for solvent metal cleaning does not specify a test method for measurement of solvent emission concentrations. However, EPA has prepared a draft test procedure specifically designed to provide accurate concentration measurements of halogenated solvent vapors emitted from sources such as the subject degreaser carbon adsorption systems. The draft procedure is entitled, "Determination of Halogenated Organics from Stationary Sources"¹. The method provides accurate concentration measurements of individual solvent compounds even if a mixture of solvents is present. It is recommended that this procedure be adopted as the compliance verification method for determination of VOC emission concentrations from degreaser carbon adsorption systems that are subject to regulations which incorporate the EPA guideline document. The CTG recommends limiting the solvent content in the exhaust gases to 25 parts per million (ppm) by volume of solvent.

As with most source testing procedures, the recommended compliance verification method requires special equipment and trained personnel. The method requires integrated bag sampling equipment for sample collection and a gas chromatograph (GC) with a flame ionization detector (FID) for sample

¹ "Determination of Halogenated Organics from Stationary Sources", Emission Measurements Branch, ESED, EPA, Research Triangle Park, North Carolina, January 1979.

analysis. A single source test, using the recommended reference method, will require approximately 30 to 40 labor hours, assuming the personnel are previously trained and the equipment is already set up for this purpose. The total cost of the necessary equipment will range from \$8,000 to \$15,000. It is apparent that conducting source tests is expensive in both labor and equipment requirements. Furthermore, source testing should not be attempted by persons unfamiliar with source sampling, nor by those who are unfamiliar with the analyzers. In light of these facts, the importance of screening tests is quite obvious. Reference method compliance testing should be reserved for those cases where screening tests have indicated potential violations and further proof is needed.

The purpose of testing is to determine if the emission standards will be met when degreasers are operated under conditions that create the maximum solvent vapor emissions. Therefore, the plant operating conditions during a test should be as follows:

- o The production rate should be the maximum rate for satisfactory operation of the work material being processed and for the type of vapor degreaser being used.
- o The testing should be conducted during operating cycles which produce the maximum emissions.
- o Work parts which produce maximum emissions (i.e., parts with porous surfaces, crevices, large mass, etc.) should be processed during testing. The conveyor speed (mpm) should be the maximum allowable. The solvent boiling rate and the vapor space barrier chilling coil temperature should be at normal operating conditions. No special work material or conditions should be used that would cause operations to be other than normal for that particular conveyORIZED degreaser application, except as specifically mentioned above.

When conducting a screening test the inspector should first determine if the process is operating normally. Although it is desirable to perform the screening test under conditions of maximum emissions, it is not mandatory as it would be for reference method compliance testing.

5.2 SOURCE TESTING SCREENING METHOD

This procedure contains seven major sections. The title of each major section and the page number where each is found is as follows:

5.2.1	Applicability	5.2-1
5.2.2	Principle	5.2-1
5.2.3	Range and Sensitivity	5.2-2
5.2.4	Calibration Apparatus	5.2-2
5.2.5	Sampling and Analysis Apparatus	5.2-4
5.2.6	Calibration Procedures	5.2-12
5.2.7	Sampling Procedures	5.2-14

5.2.1 Applicability

This suggested procedure is applicable to the measurement of single-component solvent concentrations in the effluent gases from carbon adsorption systems installed on degreasers using organic solvents. It assumes that quantities of other organic compounds which are present as oils or stabilizers are insignificant in comparison to the solvent emissions. The procedure is intended to provide a quick and relatively inexpensive approach that can be used by field inspectors to estimate solvent concentrations. It is not intended to be a compliance testing method.

5.2.2 Principle

Commercially available portable organic vapor analyzers are used to measure solvent concentration directly in the stack gases from carbon adsorption systems. The units are battery powered and are safe for use in explosion hazard areas, provided they are certified intrinsically safe by the Factory Mutual Laboratories or are designed for use in Class I, Division 1 or 2 hazardous areas as designated by the National Electrical Code.¹ Detection principles available include flame ionization, catalytic oxidation/thermal conductivity, and photoionization. The photoionization unit is an in-situ analyzer, while the flame ionization and catalytic oxidant/thermal conductivity units are extractive analyzers. The units are completely self contained requiring no ancillary sample handling equipment.

¹ "National Electric Code 1968", National Fire Protection Association, Publication NFPA No. 70-1968, Boston, 1968

5.2.3 Range and Sensitivity

The range and sensitivity varies among the different types of instruments that are available.

5.2.4 Calibration Apparatus

Calibration is most easily accomplished by obtaining commercially prepared and certified calibration gas mixtures. If this is done, then only a minimum of equipment is required. The calibration gas mixtures must contain the same solvent that is used in the degreaser to be tested. Inclusion of any other organic materials must be limited to less than 0.1 ppm as methane. The diluent gas should be pure air containing less than 0.1 ppm organics (as methane). The gas manufacturer should recommend a maximum shelf life for each cylinder, based on a maximum concentration change of ± 5 percent from the certified value. The date of gas cylinder preparation, certified concentration, and recommended shelf life should be provided by the gas manufacturer.

If commercially prepared calibration gas mixtures are not available, or if the decision is made to prepare the mixtures in-house, then more equipment is required. Suitable calibration gas mixtures can be prepared from pure solvent liquid and zero air. Such mixtures, however, should be prepared fresh each day, unless their stability for a longer period has been demonstrated.

The two following sections list the apparatus required for calibration using either commercially prepared or in-house prepared calibration gas mixtures.

5.2.4.1 Calibration Apparatus for Use With Commercially Prepared Calibration Gas Mixtures

- o Air--zero grade, certified by the manufacturer to contain less than 0.1 ppm organics (as methane).
- o Calibration Gas Mixtures--approximately 5, 25, and 50 ppm of the specific solvent in zero air, with less than 0.1 ppm of other organic material (as methane). Concentration of solvent and organic impurities to be certified by the manufacturer.
- o Gas pressure regulators--for zero air and solvent gas cylinders.

- o Tedlar bags--30 liter capacity with an integral stainless steel valve. A separate bag is reserved for each calibration gas concentration. Other bag materials may be used if it is proven that they do not affect the sample integrity.

5.2.4.2 Calibration Apparatus for Use With Standard Gas Mixtures Prepared from Pure Solvent Liquid

- o Air--zero grade, certified by the manufacturer to contain less than 0.1 ppm organics (as methane), for zero gas and dilution of solvent calibration gases.
- o Solvent--99.9+ percent pure, must be the same as the solvent used in the degreaser being tested.
- o Gas pressure regulator--for cylinder of zero air.
- o Tedlar bags--50 liter capacity with integral stainless steel valve. Other bag materials may be used if it is proven that they do not affect the sample integrity.
- o Midget impinger--30 ml capacity, with septum.
- o Hot plate--small laboratory size.
- o Beaker--500 to 1,000 ml size.
- o Syringe--1.0 microliter (μ l) capacity.
- o Syringe--5.0 microliter (μ l) capacity.
- o Syringe--25.0 microliter (μ l) capacity.
- o Dry gas meter--1 liter per revolution, smallest scale divisions no greater than 0.01 liters, $\pm$ 1% accuracy. Meter must be calibrated with a wet test meter or a spirometer at least every 12 months. Alternatively a calibrated flowmeter may be used instead of a dry gas meter, provided it is accurate to $\pm$ 1.0 percent.
- o Vacuum pump--to evacuate the bags.
- o Connecting tubing and fittings--Teflon tubing, 6.4 mm outside diameter. Stainless steel or Teflon fittings as required.

5.2.5 Sampling and Analysis Apparatus

The following instruments are listed as examples of the types of portable analyzers applicable to this procedure. Other units may also be available which will perform satisfactorily.

- o FID - OVA Model 108 or 128, Century Systems Corporation
- o Catalytic Oxidation/Thermal Conductivity - TLV Sniffer, Bacharach Instruments Company

Accessory hand-held probes which are available for all of the above instruments should be used.

5.2.6 Laboratory Calibration Procedures

These procedures are designed to determine if an analyzer is responding properly and to determine the analyzer response curve for each different solvent. Analyzer response will normally be linear over the narrow range of concentrations (zero to 50 ppm) used for calibration. The slope of the response curve will be different for each solvent, however. The calibration curves allow the operator to convert analyzer response (instrument reading) to actual concentration.

5.2.6.1 Preparation of Standard Gas Mixtures

The gases used for calibration can come from several sources. If they are available, commercially certified span gas mixtures are preferable for analyzer calibration. The span gas mixtures should contain zero air as the diluent. The solvent vapor in the span gas mixture must be the same as the solvent used in the subject degreaser. At least three different span gas concentrations should be used in order to cover the range of concentrations expected in the field. For most carbon adsorption systems, span gas concentrations of 5, 25, and 50 ppm of solvent should be adequate. In addition to the span gases, a zero gas (certified by the manufacturer to contain less than 0.1 ppm organics, as methane) is required.

If certified solvent span gas mixtures can be obtained, they are used directly to calibrate the analyzer. If such mixtures are not commercially available, then suitable calibration gas mixtures can be prepared by diluting pure solvent liquid. Prior to use, each bag must be numbered and must be leak checked using one of the following procedures.

- o Pressurize the bag to 5 to 10 cm H₂O (2 to 4 in. H₂O) using a water manometer to measure the bag pressure. Allow to stand for 10 minutes. Any displacement of the water manometer indicates a leak.
- o Pressurize the bag to 5 to 10 cm H₂O (2 to 4 in. H₂O) and allow to stand overnight. A deflated bag indicates a leak.

Note: Bag pressurization can easily be accomplished by placing a book or other suitable weight on a partially inflated bag.

If commercially prepared calibration gas mixtures are used, transfer 20 to 25 liters from each cylinder into individual Tedlar bags. Before each use the bags must be numbered, leak tested as discussed above, and evacuated. Connect each bag to the appropriate gas cylinder regulator with a short piece of Teflon tubing. Flush the tubing with the calibration gas just prior to connecting the bag. Slowly fill each bag with calibration gas. Fill a bag with zero air in the same manner. Record the appropriate data on the Calibration Curve Data Sheet (Figure 5-1). (Caution: To eliminate contamination if bags are reused, a bag should only be refilled with the solvent it originally contained. Furthermore, the new gas mixture standard should never be a lower concentration than the previous gas mixture standard.)

If the calibration gas mixtures are to be prepared from solvent liquid, assemble the apparatus as shown in Figure 5-2. Slip a short piece of 4.8 mm inside diameter rubber tubing over the Teflon tubing that attaches to the bag valve. Tighten a pinch clamp on the rubber tubing to seal the tubing. Back off the pressure control knob on the zero air cylinder regulator so that no gas will flow when the cylinder is opened. Close the outlet valve on the zero air cylinder regulator and open the zero air cylinder valve. The outlet pressure gauge on the regulator should indicate zero pressure. Open the regulator outlet valve slightly. Slowly turn the regulator pressure control knob (normally in a clockwise direction) until gas just begins to flow through the regulator. Allow the pressure in the system to reach 5 to 10 cm H₂O (2 to 4 in. H₂O) and close the regulator outlet valve. Observe the manometer water level for a 1 minute period. Any change in the manometer water level indicates there is a leak in the system that must be corrected before proceeding. After a successful leak check is obtained, remove the

Figure 5-1. Example Calibration Curve Data Sheet

Calibration Run Number _____ Resultant Calibration Curve Number _____
 Date _____ Analyzer Type _____
 Location _____ Analyzer I.D. Number _____
 Analyst _____ Solvent Gas (name) _____

	Zero Air	Mixture 1	Mixture 2	Mixture 3
Bag I.D. Number	_____	_____	_____	_____
Bag Size (liters)	_____	_____	_____	_____
Source of Calibration Gas	_____	_____	_____	_____
Calibration Gas Cylinder Number	_____	_____	_____	_____
Calibration Gas Bag Number	_____	_____	_____	_____
Calibration Gas Concentration (ppm)	_____	_____	_____	_____
Analyzer Range Setting	_____	_____	_____	_____
Analyzer Span Potentiometer Setting	_____	_____	_____	_____
Analyzer Zero Check Response	_____	_____	_____	_____
Analyzer Internal Span Check Response	_____	_____	_____	_____
Analyzer Response to Zero Air	_____			
Response to Gas Mixture		_____	_____	_____

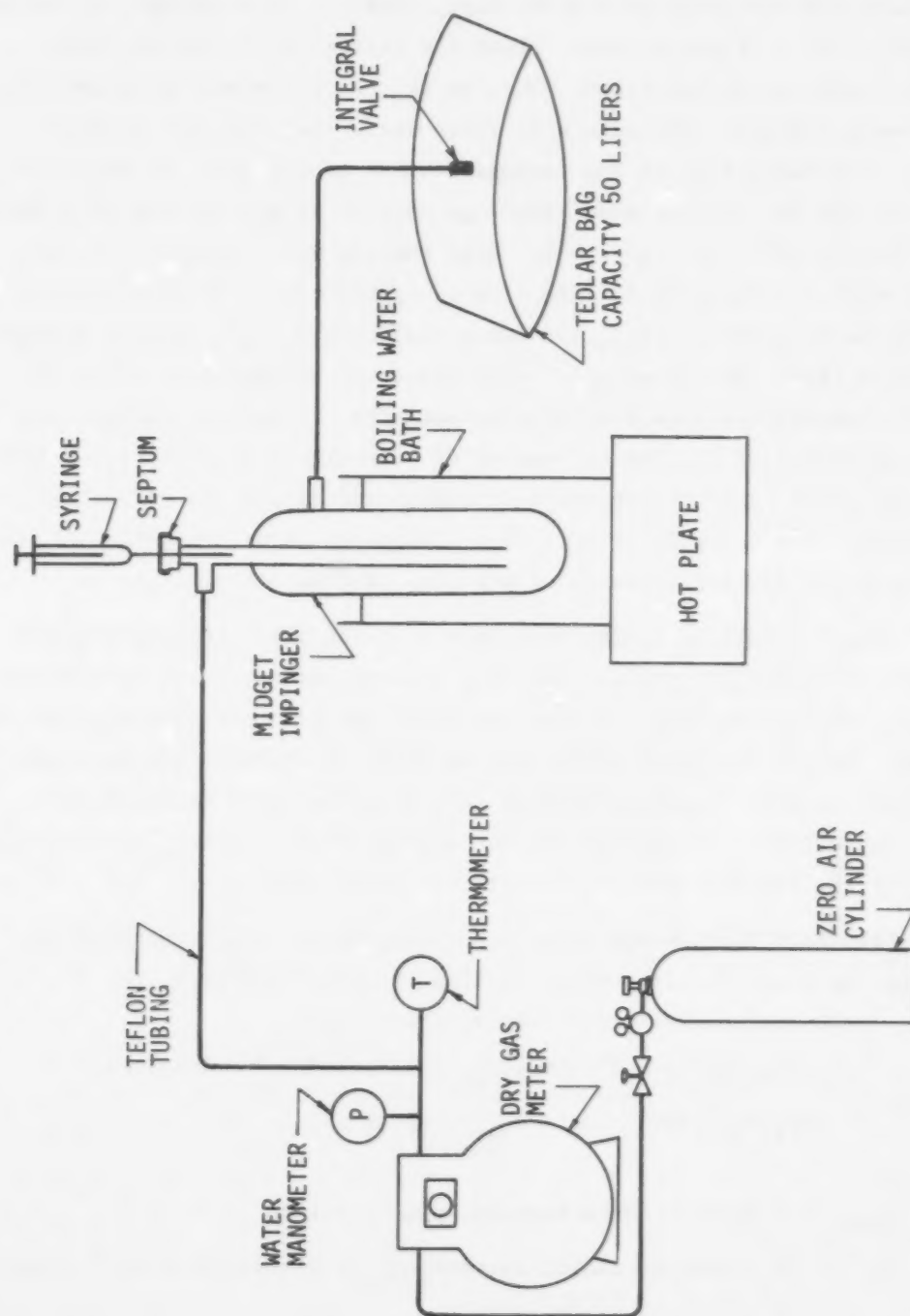


Figure 5-2. Apparatus for the Preparation of Calibration Gas Mixtures from Liquid Solvent

rubber tubing and pinch clamp from the Teflon tubing. Using the regulator outlet valve and the pressure control knob, obtain a flow through the system of approximately 3 liters/minute. Flush the system for 5 minutes, then close the regulator outlet valve. Turn on the hot plate and allow the water bath to reach boiling. Evacuate a 50 liter Tedlar bag that has passed a leak test, and connect it to the impinger outlet tubing with the bag valve closed. Record the initial meter readings (M_i) on an appropriate data sheet, such as the one shown in Figure 5-3. Open the bag valve and the zero air cylinder valve. Adjust the filling rate to approximately 3 liters/minute. Record the meter pressure (P_m), the meter temperature (T_m), and the barometric pressure (P_b). Determine the proper amount of solvent from Table 5-1. Select the smallest syringe that will accommodate the solvent volume, and fill the syringe with the desired amount of pure liquid solvent (V_s). Push the syringe needle through the impinger septum and inject the solvent into the impinger. Use a needle of sufficient length to permit injection of the liquid below the air inlet branch of the tee. Remove the syringe.

Complete filling of the bag, recording the meter temperature and pressure at 5 minute intervals. When the desired amount of air (preferably 40 liters) has been metered into the bag close the zero air cylinder and the bag valve. Record the final meter reading (M_f). Disconnect the bag from the impinger outlet. Transfer the bag to a protected area out of direct sunlight and allow it to equilibrate for approximately 1 hour. Gentle manipulation of the bag will speed the equilibration process.

Calculate the average meter temperature (T_{ma}) and pressure (P_{ma}) from the readings taken while filling the bag. Calculate the actual resultant concentration using the following equation:

$$C_{ppm} = \frac{(V_s)(Q_s)(10^3)(24.04)(760)(T_{ma} + 273)(10^6 \text{ ppm})}{(MW_s)(V_n)(10^6) (P_b + P_{ma}) (293)} \quad \text{Equation 5-1}$$

$$\frac{13.6}{}$$

where:

C_{ppm} = solvent concentration, ppm by volume

V_s = volume of liquid solvent, μl (1 microliter = 10^{-6} liter)

Q_s = density of liquid solvent at temperature used, g/ml = mg/ μl

Figure 5-3. Example Span Gas Preparation Data Sheet

Run Number _____ Bag I.D. Number _____
 Analyst _____ Date _____
 Dry Gas Meter Number _____ Solvent (name) _____
 Dilution Gas (name) _____ Solvent Liquid Lot Number _____
 Dilution Gas Cyl. Number _____ Solvent Density, Q_s , g/ml _____
 Bag Material _____ Volume of Solvent Used, V_s , (μl) _____
 Bag Capacity _____ Ambient Temperature _____
 Nominal Dilution Gas Flow Rate _____ Data for Calib. Curve Number _____
 Barometric Pres., P_b , (mm Hg) _____

Time (24-Hour Clock)	Gas Meter Reading (liters)	Gas Meter Temperature, T_m , (°C)	Gas Meter Pressure, P_m , (mm H ₂ O)
	NET, V_n =	AVG, T_{ma} =	AVG, P_{ma} =

For Liquid Solvent:
$$C_{ppm} = \frac{(V_s)(Q_s)(10^3)(24.04)(760)(T_{ma} + 273)}{(MW_s)(V_n) \left(P_b + \frac{P_{ma}}{13.6} \right) (293)}$$

$$C_{ppm} = \frac{(\quad)(\quad)(24,040)(760)(\quad + 273)}{(\quad)(\quad) \left(\quad + \frac{ \quad }{13.6} \right) (293)}$$

$$C_{ppm} = \text{_____ ppm}$$

TABLE 5-1

INJECTION VALUES FOR PREPARATION OF STANDARDS

	MOLECULAR WT (MW_s)	DENSITY AT 293° K (Q_s)	V_s , μ l LIQUID REQUIRED IN 40 l AIR FOR APPROXIMATE CONCENTRATION OF:	
			5 PPM	25 PPM
Perchloroethylene C_2Cl_4	165.85	1.6230	0.85	4.25
Trichloroethylene C_2HCl_3	131.40	1.4649	0.75	3.73
1,1,1-Trichloroethane $C_2H_3Cl_3$	133.42	1.4384	0.77	3.86
Methylene Chloride CH_2Cl_2	84.94	1.3255	0.53	2.67
Trichlorotrifluoroethane $C_2Cl_3F_3$	187.38	1.5790	0.99	4.94
Carbon Tetrachloride CCl_4	153.84	1.5940	0.80	4.01
Ethylene Dichloride $C_2H_4Cl_2$	98.96	1.2569	0.66	3.28
				50 PPM
				8.5
				7.5
				7.7
				5.3
				9.9
				8.0
				6.6

- 10^3 = conversion factor: mg to μg
- 24.04 = volume occupied by one μg -mole of pure solvent at 20°C (293°K) and 760 mm Hg, $\mu\text{l}/\mu\text{g}$ -mole
- P_b = barometric pressure, mm Hg
- P_{ma} = average meter pressure (gauge), mm H_2O
- 293 = standard temperature ($20 + 273$), $^\circ\text{K}$
- 13.6 = conversion factor, mm $\text{H}_2\text{O}/\text{mm Hg}$
- MW_s = molecular weight of solvent, $\mu\text{g}/\mu\text{g}$ -mole = g/g-mole
- V_n = net metered volume, liters. V_n = final meter reading (M_f) minus initial meter reading (M_i)
- 10^6 = conversion factor: liters to μl
- 760 = standard pressure, mm Hg
- T_{ma} = average meter temperature, $^\circ\text{C}$
- 273 = constant added to $^\circ\text{C}$ to obtain $^\circ\text{K}$
- 10^6 ppm = conversion factor: volume fraction to ppm

If the laboratory conditions are close to standard conditions the above equation can be simplified by eliminating the temperature and pressure correction terms. As long as the meter temperature is within the range of 6° to 34°C (43° to 93°F), eliminating the temperature correction will introduce a maximum error of 5% in the calculated concentration. Similarly, if the meter pressure is within the range of 722 to 792 mm Hg (28.43 to 31.42 in. Hg), eliminating the pressure correction will introduce a maximum error of 5% in the calculated concentration. Therefore, if both temperature and pressure corrections are eliminated, the maximum error that could result would be 10%, and for most laboratory conditions the error would be much less. Removing the temperature and pressure corrections and combining constants yields the following simplified equation:

$$C_{\text{ppm}} = \frac{(V_s)(Q_x)(24,040)}{(MW_s)(V_n)} \quad \text{Equation 5-2}$$

5.2.6.2 Determination of Analyzer Calibration Curve

Assemble the sampling probe to the analyzer and leak check the system in accordance with the manufacturer's instructions. Set the range switch to the lowest range that will allow analysis of the 50 ppm solvent gas mixture without an off-scale response. This setting will vary, depending on the type of analyzer used and the analyzer gain setting. In some cases it may be necessary to adjust the analyzer gain to obtain the desired response. Always refer to the manufacturer's instructions before performing any adjustments inside the instrument case. Adjust the analyzer zero and span following the manufacturer's instructions. (Use the internal electronic span check or manufacturer's span gas as appropriate for the specific analyzer being used.) Record the final analyzer settings and the other required data on the Calibration Curve Data Sheet (Figure 5-1).

Assemble bags of calibration gases prepared as discussed in Section 5.2.6.1. Tedlar bag gas mixture standards of methylene chloride, ethylene dichloride, and trichlorotrifluoroethane should be prepared fresh each day. Trichloroethylene and 1,1,1-trichloroethane can be kept for 2 days, while perchloroethylene and carbon tetrachloride can be kept for 10 days from the date of preparation. Connect the analyzer probe to the bag containing zero air. Allow the analyzer to stabilize and record the analyzer response on the Calibration Curve Data Sheet. Similarly determine the analyzer response for each of the gas mixture bags, starting with the most dilute concentration and proceeding to the next higher concentration. After completing the gas mixtures, recheck the analyzer response to the zero air. If the zero air response has drifted more than 5 percent the run should be repeated.

Plot the analyzer response for each of the calibration gases (including the zero air) versus the actual concentration of each gas. Figure 5-4 is a typical calibration curve developed in this manner. The points should fall along a straight line. If any of the plotted points fall farther than 10% from the average line, those points should be checked to determine if an error has been made. The resulting curve is then used to convert source measured analyzer response to solvent ppm concentrations.

Calibration Curve Number TRI-169
Analyzer OVA-128, S/N 12345
Range 0 to 100
Internal Calibration Point 25 ppm Methane
Name John W. Doe Date 16 July 78

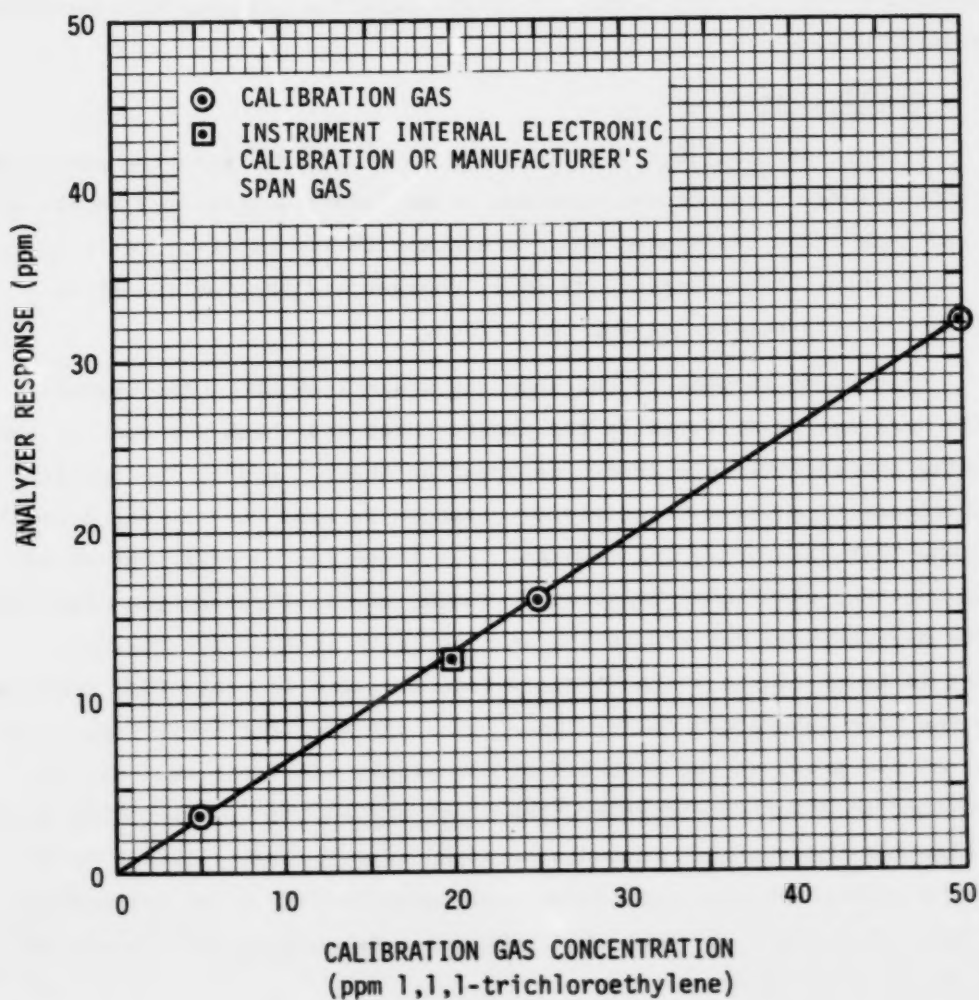


Figure 5-4. Example Calibration Curve

Once a calibration curve is developed for each solvent encountered in the field, analyzer calibrations utilizing the instrument internal electronic span check or manufacturer's span gas are sufficient for routine operation. Analyzers should initially be recalibrated as outlined in this section every 3 to 6 months to verify the accuracy of the internal electronic span check or manufacturer's span gas. If the periodic recalibrations repeatedly show a zero or span drift of more than 10 percent, more frequent recalibrations, as outlined in this section, should be performed. If the periodic recalibrations show that the instrument and the electronic span check or manufacturer's span gas are stable, a longer interval between recalibration can be instituted.

5.2.7 Sampling Procedures

Prepare the analyzer for field use in accordance with the manufacturer's instructions. Connect the sampling probe (where applicable) to the analyzer and leak check the system in accordance with the manufacturer's instructions. Make sure the batteries are fully charged and the instrument is operating properly before leaving the office.

When ready to perform the sampling again leak check the system. Zero the analyzer as directed by the manufacturer and check the span calibration using the internal electronic calibration check. Adjust the analyzer gain as necessary so that the analyzer response is equal to the value used during the last laboratory calibration. For those instruments that do not have an internal electronic calibration check, use calibration gas available from the manufacturer and adjust the analyzer gain so that the analyzer response is equal to the value obtained with the same concentration span gas during the last laboratory calibration. With the analyzer operating, place the end of the probe at the centroid of the stack. Seal off the sampling port so that no dilution air enters the stack around the probe. Allow sufficient time for the analyzer response to stabilize (normally from 5 to 90 seconds is sufficient) and record the instrument reading on an appropriate field data sheet, such as shown in Figure 5-5. Be sure to fill in all the blanks on the data sheet.

Avoid sampling during the first five minutes after an adsorption bed is placed on-line as the solvent concentration will tend to be high for

Figure 5-5. Solvent Vapor Field Data Sheet for
Screening of Carbon Adsorption Systems on
Vapor Degreasers

Plant Name _____	Sketch of Sampling Location
Address _____	
Analyzer Operator _____	Top View
Date _____	Side View
Run Number _____	
Unit Sampled _____	
Sampling Location _____	
Adsorber Bed I.D. Number _____	
Adsorber Bed On-Line At _____	
Length of Normal On-Line Cycle _____	
Analyzer Type _____	
Analyzer I.D. Number _____	
Analyzer Calibration Curve Number _____	
Leak Check Results; Beginning _____, End _____	
Analyzer Sampling Rate _____	
Analyzer Zero Response; Beginning _____, End _____	
Analyzer Span Response; Beginning _____, End _____	
Span Source _____	

Time (24-Hr. Clock)	Analyzer Range Setting	Analyzer Span Setting	Analyzer Response (_____)	Actual Concentration (ppm _____)
Average				

a short time after a bed is switched. If possible try to obtain measurements during the last portion of a bed cycle to determine if breakthrough is occurring. If low concentrations (<25 ppm) are found at the end of a cycle it is a strong indication that the system is operating in compliance. If breakthrough is found and the measured concentrations exceed the 25 ppm limitation, then multiple samples should be taken at regular intervals throughout an entire cycle. This will allow the calculation of the average emission concentration during the cycle.

At the completion of the sampling run, perform a final leak check and check the analyzer zero and span response. If the system has developed a leak or if the analyzer has drifted more than 5% for either zero or span, the run should be repeated.

Using the calibration curve prepared according to Section 5.2.6.2, determine the actual solvent concentration that corresponds to the observed analyzer response. Record these corresponding solvent concentrations on the field data sheet. If multiple samples have been obtained, calculate the average solvent concentration and enter it on the field data sheet.

The methodology required for compliance testing requires the use of accurate instruments, operated by experienced personnel, in a careful and thorough manner. The following testing procedure is designed to accurately determine the average solvent concentration in the exhaust gases of a carbon adsorption system during a complete adsorption cycle, regardless of whether the solvent is a single compound or a mixture of compounds. The procedure utilizes a gas chromatograph with a flame ionization detector that can be used to separate a mixture of solvent vapors and determine the concentration of each component.

Samples are collected by the integrated bag technique. A bag is filled continuously over an entire cycle, yielding a single sample that represents an average of the emissions during that cycle. Three such cycles should be sampled and the results of the three runs should be averaged to determine the average emission concentration for the source. The samples need not be analyzed in the field, provided the bag samples are properly protected as outlined in the method.

The method has not been promulgated as an EPA Reference Method, so no method number has been assigned at this time. The method was written in anticipation that either an NSPS or NESHAP regulation would be promulgated for drycleaning and degreasing, so it is quite appropriate for testing degreaser carbon adsorption systems. The draft method is reprinted in its entirety in the sections below.

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Performance of this method should not be attempted by persons unfamiliar with the operation of a gas chromatograph, nor by those who are unfamiliar with source sampling, as there are many details that are beyond the scope of this presentation. Care must be exercised to prevent exposure of sampling personnel to hazardous emissions.

5.3.1 Principle and Applicability

5.3.1.1 Principle

An integrated bag sample of stack gas containing one or more halogenated organics is subjected to gas chromatographic (GC) analysis, using a flame ionization detector (FID).

5.3.1.2 Applicability

The method is applicable to the measurement of halogenated organics such as carbon tetrachloride, ethylene dichloride, perchloroethylene, trichloroethylene, methylene chloride, 1-1-1 trichloroethane, and trichlorotrifluoroethane in stack gases only from specified processes. It is not applicable where the gases are contained in particulate matter.

5.3.2 Range and Sensitivity

The procedure described herein is applicable to the measurement of halogenated organics in the 0.1 to 200 ppm range. The upper limit may be extended by further calibration or by dilution of the sample.

5.3.3 Interferences

The chromatograph column with the corresponding operating parameters herein described has been represented as being useful for producing adequate resolution of halogenated organics. However, resolution interferences may be encountered on some sources. Also, the chromatograph operator may know of a column that will produce a superior resolution of the particular compound of interest without reducing the response to that compound, as specified in Section 5.3.4.3.1.

In any event, the chromatograph operator shall select a column which is best suited to his particular analysis problem, subject to the approval of the Administrator. Such approval shall be considered automatic provided that confirming data produced through a demonstrably adequate supplemental analytical technique, such as analysis with a different column or GC/mass spectroscopy, is available for review by the Administrator.

5.3.4 Apparatus

5.3.4.1 Sampling

See Figure 5-6.

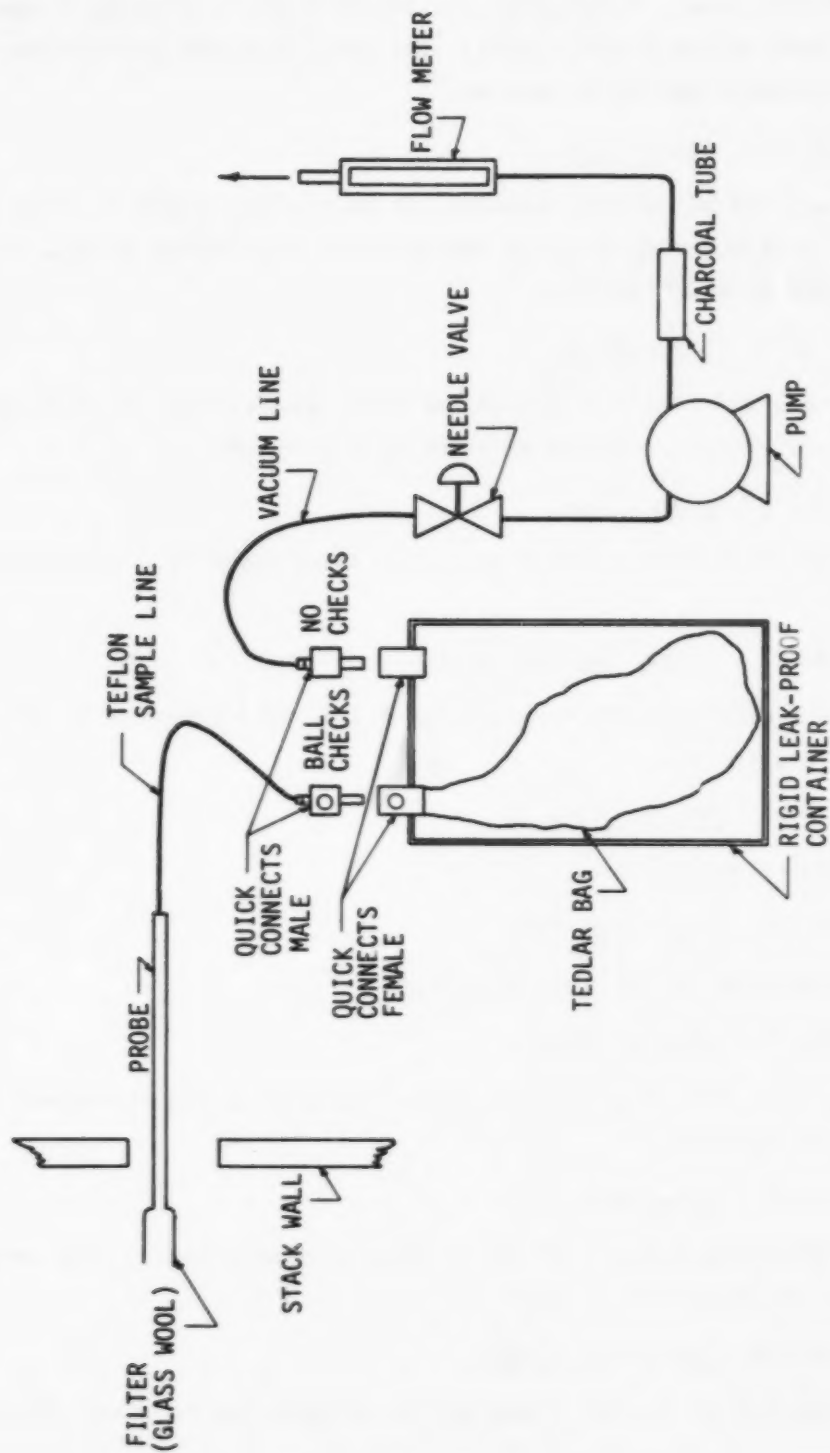


Figure 5-6. Integrated Bag Sampling Apparatus Assembly

5.3.4.1.1 Probe

Stainless steel, Pyrex glass, or Teflon tubing according to stack temperature, each equipped with a glass wool plug to remove particulate matter if particulate matter is present.

5.3.4.1.2 Sample Line

Teflon, 6.4 mm outside diameter, of sufficient length to connect probe to bag. A new unused piece is employed for each series of bag samples that constitutes an emission test.

5.3.4.1.3 Connections

Male (2) and female (2) stainless steel quick connects, with ball checks (one pair without) located as shown in Figure 5-6.

5.3.4.1.4 Sample Bags

Tedlar or aluminized Mylar bags, 100 liter capacity. To contain sample.

5.3.4.1.5 Sample Bag Containers

Rigid leakproof containers for 5.3.4.1.4, with covering to protect contents from sunlight.

5.3.4.1.6 Needle Valve

To adjust sample flow rate.

5.3.4.1.7 Pump--Leak-Free

Minimum capacity 2 liters per minute.

5.3.4.1.8 Charcoal Tube

To prevent admission of halogenated organics to the atmosphere in the vicinity of samplers.

5.3.4.1.9 Flow Meter

For observing sample flow rate; capable of measuring a flow range from 0.10 to 1.00 liters per minute.

5.3.4.1.10 Connecting Tubing

Teflon, 6.4 mm outside diameter, to assemble sample train (Figure 5-6).

5.3.4.2 Sample Recovery

5.3.4.2.1 Tubing

Teflon, 6.4 mm outside diameter, to connect bag to gas chromatograph sample loop. A new unused piece is employed for each series of bag samples that constitutes an emission test, and is to be discarded upon conclusion of analysis of those bags.

5.3.4.3 Analysis

5.3.4.3.1 Gas Chromatograph

With FID, potentiometric strip chart recorder and 1.0 to 2.0 ml sampling loop in automatic sample valve. The chromatographic system shall be capable of producing a response to 0.1 ppm of the halogenated organic compound that is at least as great as the average noise level. (Response is measured from the average value of the baseline to the maximum of the waveform, while standard operating conditions are in use.)

5.3.4.3.2 Chromatographic Column

Stainless steel, 3.04 m x 3.2 mm, containing 20 percent SP-2100/0.1 percent Carbowax 1500 to 100/120 Supelcoport. Other columns can be used, provided that the precision and accuracy of the analysis of standards are not impaired. Information confirming that adequate resolution of the halogenated organic compound peak is accomplished should be available. Adequate resolution is defined as an area overlap of not more than 10 percent of the halogenated organic compound peak by an interferent peak. Calculation of area overlap is explained in Appendix C, Supplement A: "Determination of Adequate Chromatographic Peak Resolution."

5.3.4.3.3 Flow Meters (2)

Rotameter type, 0 to 100 ml/min capacity.

5.3.4.3.4 Gas Regulators

For required gas cylinders.

5.3.4.3.5 Thermometer

Accurate to one degree centigrade, to measure temperature of heated sample loop at time of sample injection.

5.3.4.3.6 Barometer

Accurate to 5 mm Hg, to measure atmospheric pressure around gas chromatograph during sample analysis.

5.3.4.3.7 Pump--Leak-free

Minimum capacity 100 ml/min.

5.3.4.3.8 Recorder

Strip chart type, optionally equipped with disc integrator or electronic integrator.

5.3.4.3.9 Planimeter

Optional, in place of disc or electronic integrator, for Section 5.3.4.3.8 to measure chromatograph peak areas.

5.3.4.4 Calibration

Sections 5.3.4.4.2 through 5.3.4.4.6 are for Section 5.3.7.1 which is optional.

5.3.4.4.1 Tubing

Teflon, 6.4 mm outside diameter, separate pieces marked for each calibration concentration.

5.3.4.4.2 Tedlar or Aluminized Mylar Bags

50-liter capacity, with valve; separate bag marked for each calibration concentration.

5.3.4.4.3 Syringe

25 μ l, gas tight, individually calibrated, to dispense liquid halogenated organic solvent.

5.3.4.4.4 Syringe

50 μ l, gas tight, individually calibrated, to dispense liquid halogenated organic solvent.

5.3.4.4.5 Dry Gas Meter, With Temperature and Pressure Gauges

Accurate to ± 2 percent, to meter nitrogen in preparation of standard gas mixtures, calibrated at the flowrate used to prepare standards.

5.3.4.4.6 Midget Impinger/Hot Plate Assembly

To vaporize solvent.

5.3.5 Reagents

It is necessary that all reagents be of chromatographic grade.

5.3.5.1 Analysis

5.3.5.1.1 Helium Gas or Nitrogen Gas

Zero grade, for chromatographic carrier gas.

5.3.5.1.2 Hydrogen Gas

Zero grade.

5.3.5.1.3 Oxygen Gas or Air as Required by the Detector

Zero grade.

5.3.5.2 Calibration

Use one of the following options: either 5.3.5.2.1 or 5.3.5.2.2, or 5.3.5.2.3.

5.3.5.2.1 Halogenated organic compound

99 mol percent pure, certified by the manufacturer to contain a minimum of 99 mol percent of the particular halogenated organic compounds; for use in the preparation of standard gas mixtures as described in Section 5.3.7.1.

5.3.5.2.2 Nitrogen Gas

Zero grade, for preparation of standard gas mixtures as described in Section 5.3.7.1.

5.3.5.2.3 Cylinder Standards (3)

Gas mixture standards (200, 100, and 50 ppm of the halogenated organic compound of interest, in nitrogen) for which the gas composition has been certified with an accuracy of ± 3 percent or better by the manufacturer. The manufacturer must have recommended a maximum shelf life for each cylinder so that the concentration does not change by greater than ± 5 percent from the certified value. The date of gas cylinder preparation, certified concentration of the halogenated organic compound and recommended maximum shelf

life must have been affixed to the cylinder before shipment from the gas manufacturer to the buyer. These gas mixture standards may be directly used to prepare a chromatograph calibration curve as described in Section 5.3.7.2.2.

5.3.5.2.3.1 Cylinder Standards Certification

The concentration of the halogenated organic compound in nitrogen in each cylinder must have been certified by the manufacturer by a direct analysis of each cylinder using an analytical procedure that the manufacturer had calibrated on the day of cylinder analysis. The calibration of the analytical procedure shall, as a minimum, have utilized a three-point calibration curve. It is recommended that the manufacturer maintain two calibration standards and use these standards in the following way: (1) a high concentration standard (between 200 and 400 ppm) for preparation of a calibration curve by an appropriate dilution technique; (2) a low concentration standard (between 50 and 100 ppm) for verification of the dilution technique used. If the difference between the apparent concentration read from the calibration curve and the true concentration assigned to the low concentration standard exceeds 5 percent of the true concentration, determine the source of error and correct it, then repeat the three-point calibration.

5.3.5.2.3.2 Establishment and Verification of Calibration Standards

The concentration of each calibration standard must have been established by the manufacturer using reliable procedures. Additionally, each calibration standard must have been verified by the manufacturer by one of the following procedures, and the agreement between the initially determined concentration value and the verification concentration value must be within ± 5 percent: (1) verification value determined by comparison with a gas mixture prepared in accordance with the procedure described in Section 5.3.7.1.1 and using 99 mol percent of the halogenated organic compounds, or (2) verification value obtained by having the calibration standard analyzed by the National Bureau of Standards, if such analysis is available. All calibration standards must be reverified on a time interval consistent with the shelf life of the cylinder standards sold.

5.3.5.2.4 Audit Cylinder Standards (2)

Gas mixture standards identical in preparation to those in Section 5.3.5.2.3 (the halogenated organic compounds of interest, in nitrogen),

except the concentrations are only known to the person supervising the analysis of samples. The concentrations of the audit cylinders should be: one low concentration cylinder in the range of 25 to 50 ppm, and one high concentration cylinder in the range of 200 to 300 ppm. When available, audit cylinders may be obtained by contacting: EPA, Environmental Monitoring and Support Laboratory, Quality Assurance Branch (MD-77), Research Triangle Park, North Carolina 27711. If audit cylinders are not available at EPA, an alternate source must be secured.

5.3.6. Procedure

5.3.6.1 Sampling

Assemble the sample train as in Figure 5-6. Perform a bag leak check according to Section 5.3.7.3.2. Join the quick connects as illustrated, and determine that all connections between the bag and the probe are tight. Place the end of the probe at the centroid of the stack and start the pump with the needle valve adjusted to yield a flow of 0.5 lpm. After a period of time sufficient to purge the line several times has elapsed, connect the vacuum line to the bag and evacuate the bag until the rotameter indicates no flow. At all times, direct the gas exiting the rotameter away from sampling personnel. Then reposition the sample and vacuum lines and begin the actual sampling, keeping the rate constant. At the end of the sample period, shut off the pump, disconnect the sample line from the bag, and disconnect the vacuum line from the bag container. Protect the bag container from sunlight.

5.3.6.2 Sample Storage

Sample bags must be kept out of direct sunlight and must be protected from heat. Analysis must be performed within 1 day of sample collection for methylene chloride, ethylene dichloride and trichlorotrifluoroethane. Analysis of perchloroethylene, trichloroethylene, 1,1,1-trichloroethane and carbon tetrachloride must be performed within 2 days.

5.3.6.3 Sample Recovery

With a new piece of Teflon tubing identified for that bag, connect a bag inlet valve to the gas chromatograph sample valve. Switch the valve to receive gas from the bag through the sample loop. Arrange the equipment so the sample gas passes from the sample valve to a 0-100 ml/min rotameter with flow control valve followed by a charcoal tube and a 0-1 inch

w.g. pressure gauge. Sample flow may be maintained either by a vacuum pump or container pressurization if the collection bag remains in the rigid container. After sample loop purging is ceased, allow the pressure gauge to return to zero before activating the gas sampling valve.

5.3.6.4 Analysis

Set the column temperature to 100°C, and the detector temperature to 225°C. When optimum hydrogen and oxygen flow rates have been determined, verify and maintain these flow rates during all chromatograph operations. Using zero helium or nitrogen as the carrier gas, establish a flow rate in the range consistent with the manufacturer's requirements for satisfactory detector operation. A flow rate of approximately 20 ml/min should produce adequate separations. Observe the base line periodically and determine that the noise level has stabilized and that base line drift has ceased. Purge the sample loop for thirty seconds at a rate of 100 ml/min, then activate the sample valve. Record the injection time (the position of the pen on the chart at the time of sample injection), the sample number, the sample loop temperature, the column temperature, carrier gas flow rate, chart speed and the attenuator setting. Record the laboratory pressure. From the chart, note the peak having the retention time corresponding to the halogenated organic compound peak as determined in Section 5.3.7.2.1. Measure the halogenated organic compound peak area, A_m , by use of a disc integrator, electronic integrator, or a planimeter. Record A_m and the retention time. Repeat the injection at least two times or until two consecutive values for the total area of the peak do not vary more than 5 percent. The average value for these two total areas will be used to compute the bag concentration.

5.3.6.5 Determine Ambient Conditions

Measure the ambient temperature and barometric pressure near the bag. From a water saturation vapor pressure table, determine and record the water vapor content of the bag as a decimal figure. (Assume the relative humidity to be 100 percent unless a lesser value is known.)

5.3.7 Standards, Calibration, and Quality Assurance

5.3.7.1 Standards

5.3.7.1.1 Preparation of Standard Gas Mixtures

(Optional-delete if cylinder standards are used.) Assemble the apparatus shown in Figure 5-7. Check that all fittings are tight. Evacuate a 50-liter Tedlar or aluminized Mylar bag that has passed a leak check (described in Section 5.3.7.3.2) and meter in about 50 liters of nitrogen. Measure the barometric pressure, the relative pressure at the dry gas meter, and the temperature at the dry gas meter. Refer to Table 5-2. While the bag is filling, use the 50 μ l syringe to inject through the septum on top of the impinger, the quantity required to yield a concentration of 200 ppm. In a like manner, use the 25 μ l syringe to prepare bags having approximately 100 and 50 ppm concentrations. To calculate the specific concentrations, refer to Section 5.3.8.1. Tedlar bag gas mixture standards of methylene chloride, ethylene dichloride, and trichlorotrifluoroethane may be used for 1 day; trichloroethylene and 1,1,1-trichloroethane for 2 days; perchloroethylene and carbon tetrachloride for 10 days from the date of preparation. (Caution: Contamination may be a problem when a bag is reused if the gas mixture standard is a lower concentration than the previous gas mixture standard.)

5.3.7.2 Calibration

5.3.7.2.1 Determination of Halogenated Organic Compound Retention Time

This section can be performed simultaneously with Section 5.3.7.2.2. Establish chromatograph conditions identical with those in Section 5.3.6.3 above. Determine proper attenuator position. Flush the sampling loop with zero helium or nitrogen and activate the sample valve. Record the injection time, the sample loop temperature, the column temperature, the carrier gas flow rate, the chart speed and the attenuator setting. Record peaks and detector responses that occur in the absence of the halogenated organic. Maintain conditions (with the equipment plumbing arranged identically to Section 5.3.6.3), flush the sample loop for 30 seconds at the rate of 100 ml/min with one of the halogenated organic compound calibration mixtures, and activate the sample valve. Record the injection time. Select the peak that corresponds to the halogenated organic compound. Measure the distance on

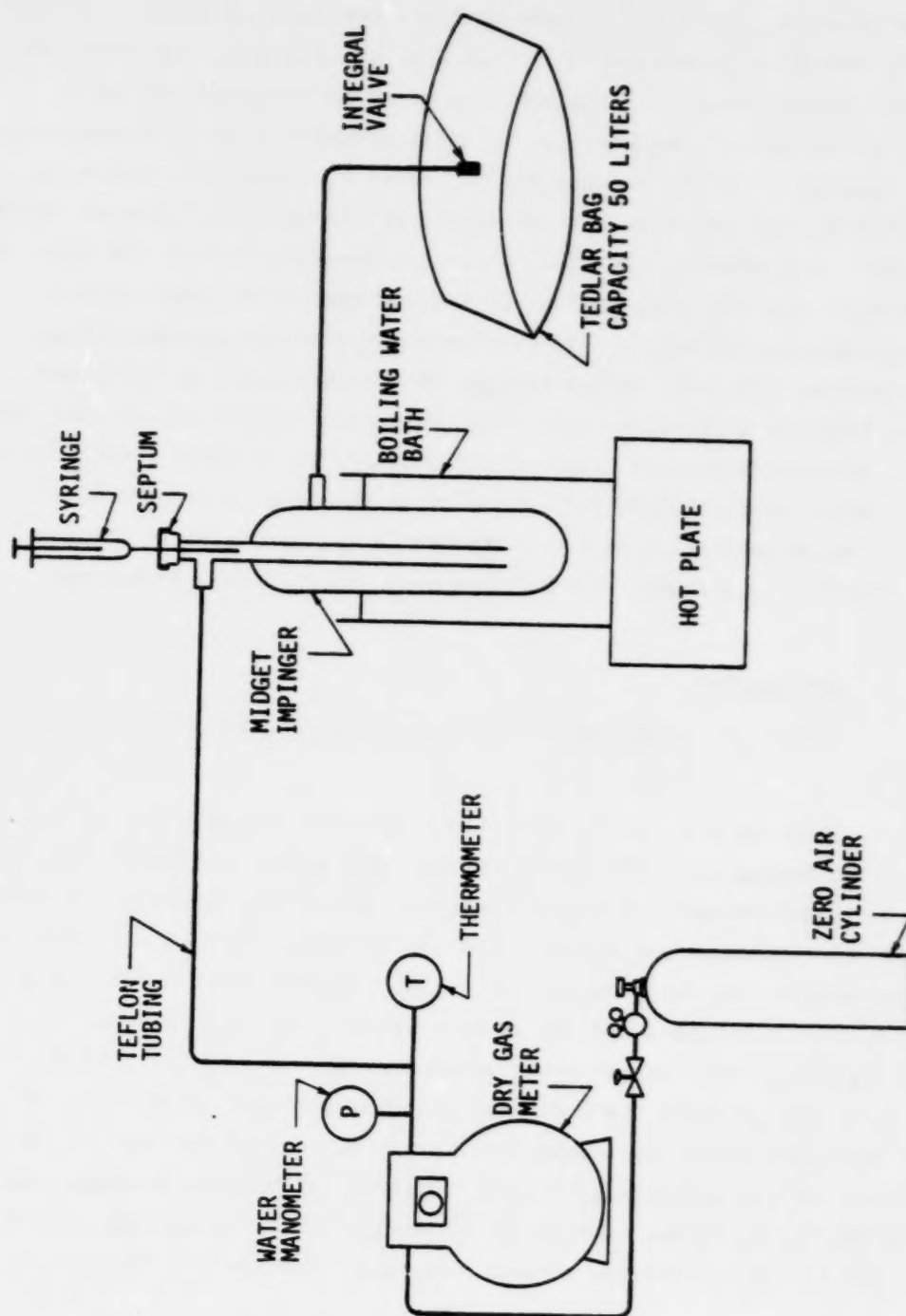


Figure 5-7. Apparatus for the Preparation of Calibration Gas Mixtures from Liquid Solvent

TABLE 5-2

INJECTION VALUES FOR PREPARATION OF STANDARDS

(Optional, See Section 5.3.7.1.1)

Compound	Molecular Wt. (M)	Density at 293° K (D)	μ l Liquid Required in 50 l N ₂ for Approximate Concentration of:		
			200 ppm	100 ppm	50 ppm
Perchloroethylene C ₂ Cl ₄	165.85	1.6230	42.5	21.2	10.6
Trichloroethylene C ₂ HCl ₃	131.40	1.4649	37.3	18.6	9.3
1,1,1-Trichloroethane C ₂ H ₃ Cl ₃	133.42	1.4384	38.6	19.3	9.6
Methylene Chloride CH ₂ Cl ₂	84.94	1.3255	26.6	13.3	6.7
Trichlorotrifluoroethane C ₂ Cl ₃ F ₃	187.38	1.5790	49.3	24.7	12.3
Carbon Tetrachloride CCl ₄	153.84	1.5940	40.1	20.1	10.0
Ethylene Dichloride C ₂ H ₄ Cl ₂	98.96	1.2569	32.7	16.4	8.2

the chart from the injection time to the time at which the peak maximum occurs. This distance divided by the chart speed is defined as the halogenated organic compound peak retention time. Since it is possible that there will be other organics present in the sample, it is very important that positive identification of the halogenated organic compound peak be made.

5.3.7.2.2 Preparation of Chromatograph Calibration Curve

Make a gas chromatographic measurement of each standard gas mixture (described in Section 5.3.5.2.3 or 5.3.7.1.1) using conditions identical with those listed in Sections 5.3.6.3 and 5.3.6.4. Flush the sampling loop for 30 seconds at the rate of 100 ml/min with one of the standard gas mixtures and activate the sample valve. Record C_c , the concentration of halogenated organic injected, the attenuator setting, chart speed, peak area, sample loop temperature, column temperature, carrier gas flow rate, and retention time. Record the laboratory pressure. Calculate A_c , the peak area multiplied by the attenuator setting. Repeat until two consecutive injection areas are within 5 percent, then plot the average of those two values versus C_c . When the other standard gas mixtures have been similarly analyzed and plotted, draw a straight line through the points. Perform calibration daily, or before and after each set of bag samples, whichever is more frequent.

5.3.7.3 Quality Assurance

5.3.7.3.1 Analysis Audit

Immediately after the preparation of the calibration curve and prior to the sample analyses, perform the analysis audit described in Appendix C, Supplement B: "Procedure for Field Auditing GC Analysis."

5.3.7.3.2 Bag Leak Checks

While performance of this section is required subsequent to bag use, it is also advised that it be performed prior to bag use. After each use, make sure a bag did not develop leaks as follows: to leak check, connect a water manometer and pressurize the bag to 5-10 cm H_2O (2-4 in. H_2O). Allow to stand for 10 minutes. Any displacement in the water manometer indicates a leak. Also, check the rigid container for leaks in this manner. (Note: an alternative leak check method is to pressurize the bag to 5-10 cm H_2O or 2-4 in. H_2O and allow to stand overnight. A deflated bag indicates a leak.) For each sample bag in its rigid container, place a rotameter in

line between the bag and the pump inlet. Evacuate the bag. Failure of the rotameter to register zero flow when the bag appears to be empty indicates a leak.

5.3.8. Calculations

5.3.8.1 Optional Standards Concentrations

Calculate each halogenated organic standard concentration prepared in accordance with Section 5.3.7.1.1 as follows:

$$C_c = \frac{(B\mu l) \left(\frac{D\mu g}{\mu l} \right) \left(\frac{10^3 \mu g}{mg} \right) \left(\frac{\mu g\text{-mole}}{M \mu g} \right) (24.055\mu l) (10^6)}{(V_m)(Y) \left(10^6 \frac{\mu l}{l} \right) \left(\frac{293}{T_m} \right) \left(\frac{P_m}{760} \right)}$$

$$C_c = \frac{\frac{BD}{M} (24.055 \times 10^3)}{V_m Y \frac{293}{T_m} \frac{P_m}{760}}$$

Equation 5-3

Where:

- C_c = Standard concentration in ppm.
- B = Number of μl injected.
- V_m = Gas volume measured by dry gas meter in liters.
- Y = Dry gas meter calibration factor.
- P_m = Absolute pressure of the dry gas meter, mm Hg.
- T_m = Absolute temperature of the dry gas meter, °K.
- D = Density of compound at 293° K.
- M = Molecular weight of compound.
- 24.055 = Ideal gas constant at 293° K, 760 mm Hg.
- 10^6 = Conversion factor, ppm.

5.3.8.2 Sample Concentrations

From the calibration curve described in Section 5.3.7.2.2 above, select the value of C_c that corresponds to A_c . Calculate C_s as follows:

$$C_s = \frac{C_c P_r T_1}{P_1 T_r (1 - S_{wb})}$$

Equation 5-4

- Where:
- S_{wb} = The water vapor content of the bag sample, as analyzed.
 - C_s = The concentration of the halogenated organic in the sample in ppm.
 - C_c = The concentration of the halogenated organic indicated by the gas chromatograph, in ppm.
 - P_r = The reference pressure, the laboratory pressure recorded during calibration, mm Hg.
 - T_1 = The sample loop temperature on the absolute scale at the time of analysis, °K.
 - P_1 = The laboratory pressure at time of analysis, mm Hg.
 - T_r = The reference temperature, the sample loop temperature recorded during calibration, °K.

5.3.9. References

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2. Bulletin 747. "Separation of Hydrocarbons" 1974. Supelco, Inc. Bellefonte, Pennsylvania 16823.
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5.4 MATERIAL BALANCE

A material balance test provides data to quantify the amount of solvent input into a degreaser over a sufficiently long time period so that an average emission rate can be calculated. This technique is useful where pounds per hour or pounds per day emission limitations are applicable, such as with "Rule 66" type regulations. It may also be useful when an accurate plant site emissions inventory is required.

In order to perform a material balance test, the following general procedure should be used:

1. Fill the solvent sump (or bath) to a marked level.
2. Begin normal operation of the degreaser, recording the quantity of make-up solvent and hours of operation.
3. Conduct the test for about four weeks, or until the solvent loss is great enough to minimize the error in measurement.
4. Refill the solvent sump to the original, marked level, recording the volume of solvent added. The total volume of solvent added during the test period approximately equals the solvent emitted.

Degreasers that are used in manufacturing operations are in service often enough such that it is necessary to drain the contaminated solvent from the sump and recharge it with clean solvent. Under these circumstances this cycle (often approximately one week) is long enough to minimize measurement errors.

Marking the sump liquid level is generally impractical in open top and conveyORIZED degreasers due to safety problems (exposure to high solvent concentrations and heat) and accessibility. An alternative for open top vapor degreasers is to use a dip stick to record the solvent level. The stick should be made of a nonabsorbent material such as metal and care should be taken not to disturb the air/vapor interface if the sump heat is on. Also, precautions should be taken in handling the hot dip stick. For conveyORIZED

degreasers the manufacturer's instruction manual should be consulted for topping off the sump. This may also be necessary for very large open top vapor degreasers.

Although a highly accurate material balance is not usually necessary, the following modifications will improve the accuracy of the test.

1. Clean the degreaser sump before testing.
2. Record the amount of solvent added to the tank with a flow meter.
3. Record the weight and type of work load degreased each day.
4. At the end of the test run, pump out the used solvent and measure the amount with a flow meter. Also, approximate the volume of metal chips and other material remaining in the emptied sump, if significant.
5. Bottle a sample of the used solvent and analyze it to find the percent that is oil and other contaminants. The oil and solvent proportions can be estimated by weighing samples of used solvent before and after boiling off the solvent. Calculate the volume of oils in the used solvent. The volume of solvent displaced by this oil along with the volume of make-up solvent added during operations is equal to the solvent emission.

Proper maintenance and adjustment should be performed on the degreaser and control system before the test period.

Figure 5-8 illustrates an example material balance data sheet. The control official or degreaser operator is encouraged to develop a data sheet that is specific to the particular test being conducted.

Figure 5-8. Material Balance Data Sheet

1. BUSINESS LICENSE NAME OF CORPORATION, COMPANY, OR INDIVIDUAL OWNER OR GOVERNMENTAL AGENCY:																																													
2a. MAILING ADDRESS	2b. PLANT ADDRESS WHERE THIS DEGREASER IS LOCATED																																												
3. SOURCE NO. (PERMIT NUMBER, WEBS ID., ETC.)																																													
4. NAME AND TITLE OF AUTHORIZED COMPANY REPRESENTATIVE FURNISHING DATA: SIGNATURE:																																													
5. TELEPHONE NO.:																																													
6. DEGREASER MANUFACTURER: _____ MODEL NO. _____ SERIAL NO. _____ INSIDE DIMENSIONS OF TANK (FT): _____ WIDE X _____ LONG X _____ DEEP																																													
MATERIAL BALANCE DATA																																													
7. BEFORE BEGINNING OPERATION FILL THE CLEANED SOLVENT SUMP TO A MARKED LEVEL AND NOTE APPROXIMATE DISTANCE FROM TOP EDGE OF TANK. DISTANCE FROM TOP EDGE OF TANK _____ INCHES																																													
8. BEGIN NORMAL OPERATION OF DEGREASER AND RECORD HOURS OF OPERATION AND MAKE UP SOLVENT ON CHART																																													
<u>HOURS OF OPERATION</u> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">DATE</th> <th style="width: 50%;">TIME</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table>	DATE	TIME																					<u>MAKE UP SOLVENT</u> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">DATE ADDED</th> <th style="width: 50%;">NUMBER OF GALLONS</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table>	DATE ADDED	NUMBER OF GALLONS																				
DATE	TIME																																												
DATE ADDED	NUMBER OF GALLONS																																												
TOTAL HOURS OPERATED _____	TOTAL GALLONS ADDED _____																																												
9. OPERATE UNIT FOR SEVERAL WEEKS OR UNTIL SOLVENT MUST BE CHANGED DUE TO CONTAMINATION. HALT OPERATION AND REFILL SOLVENT SUMP TO ORIGINAL MARKED LEVEL: RECORD VOLUME OF SOLVENT ADDED. VOLUME OF SOLVENT ADDED AFTER OPERATION HALTED _____ GALLONS																																													
10. TOTAL VOLUME OF SOLVENT USED (ADD 8 & 9) _____ GALLONS TOTAL TIME OF RUN _____ HOURS																																													
11. IF SIGNIFICANT, ESTIMATE THE VOLUME OF METAL CHIPS AND OTHER MATERIAL ACCUMULATED IN THE SUMP:																																													

APPENDIX A

LIST OF REFERENCES

SOLVENT METAL CLEANING PROCESSES

LIST OF REFERENCES

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2. DOW Chemicals, USA: Modern Vapor Degreasing and DOW Chlorinated Solvents. Form No. 100-5185-77.
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"Three Dip Degreaser", Bulletin 2114.11
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"Immersion/Spray Degreasers with Ultrasonic Option", Bulletin 2113.16
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"Solvent Cleaning Systems", Bulletin 2172.2
"Liquid Vapor Degreaser", Bulletin 2114.18
Baron-Blakeslee, Inc., Chicago, Illinois

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"Tri-Ethane", Bulletin 35A
PPG Industries, Inc., Pittsburgh, PA
14. Pendleton, G., Kleer Flo Company, personal communication, March 9, 1979
15. "Vapor Spray Degreaser, Model DH"
"Vapor Spray Degreaser, Model NP"
"Vapor Spray Degreasers, Model DM"
Delta Industries, Santa Fe Springs, CA

APPENDIX B
CTG GUIDELINES

CONTROL SYSTEMS FOR COLD CLEANING

Control System A

Control Equipment

1. Cover
2. Facility for draining cleaned parts
3. Permanent, conspicuous label, summarizing the operating requirements

Operating Requirements:

1. Do not dispose of waste solvent or transfer it to another party, such that greater than 20 percent of the waste (by weight) can evaporate into the atmosphere.* Store waste solvent only in covered containers.
2. Close degreaser cover whenever not handling parts in the cleaner.
3. Drain cleaned parts for at least 15 seconds or until dripping ceases.

Control System B

Control Equipment:

1. Cover: Same as in System A, except if (a) solvent volatility is greater than 2 kPa (15 mm Hg or 0.3 psi) measured at 38°C (100°F),** (b) solvent is agitated, or (c) solvent is heated, then the cover must be designed so that it can be easily operated with one hand. (Covers for larger degreasers may require mechanical assistance, by spring loading, counterweighting or powered systems.)
2. Drainage facility: Same as in System A, except that if solvent volatility is greater than about 4.3 kPa (32 mm Hg or 0.6 psi) measured at 38°C (100°F), then the drainage facility must be internal, so that parts are enclosed under the cover while draining. The drainage facility may be external for applications where an internal type cannot fit into the cleaning system.
3. Label: Same as in System A
4. If used, the solvent spray must be a solid, fluid stream (not a fine, atomized or shower type spray) and at a pressure which does not cause excessive splashing.
5. Major control device for highly volatile solvents: If the solvent volatility is > 4.3 kPa (32 mm Hg or 0.6 psi) measured at 38°C (100°F), or if solvent is heated above 50°C (120°F), then one of the following control devices must be used:
 - a. Freeboard that gives a freeboard ratio*** ≥ 0.7
 - b. Water cover (solvent must be insoluble in and heavier than water)
 - c. Other systems of equivalent control, such as a refrigerated chiller or carbon adsorption.

Operating Requirements:

Same as in System A

*Water and solid waste regulations must also be complied with.

**Generally solvents consisting primarily of mineral spirits (Stoddard) have volatility - 2 kPa.

***Freeboard ratio is defined as the freeboard height divided by the width of the degreaser.

COMPLETE CONTROL SYSTEMS FOR OPEN TOP VAPOR DEGREASERS

Control System A

Control Equipment:

1. Cover that can be opened and closed easily without disturbing the vapor zone.

Operating Requirements:

1. Keep cover closed at all times except when processing work loads through the degreaser.
2. Minimize solvent carry-out by the following measures:
 - a. Rack parts to allow full drainage.
 - b. Move parts in and out of the degreaser at less than 3.3 m/sec. (11 ft/min).
 - c. Degrease the work load in the vapor zone at least 30 sec. or until condensation ceases.
 - d. Tip out any pools of solvent on the cleaned parts before removal.
 - e. Allow parts to dry within the degreaser for at least 15 sec. or until visually dry.
3. Do not degrease porous or absorbent materials, such as cloth, leather, wood or rope.
4. Work loads should not occupy more than half of the degreaser's open top area.
5. The vapor level should not drop more than 10 cm (4 in.) when the work load enters the vapor zone.
6. Never spray above the vapor level.
7. Repair solvent leaks immediately, or shutdown the degreaser.
8. Do not dispose of waste solvent or transfer it to another party such that greater than 20 percent of the waste (by weight) will evaporate into the atmosphere. Store waste solvent only in closed containers.
9. Exhaust ventilation should not exceed $20 \text{ m}^3/\text{min. per m}^2$ (65 cfm per ft^2) of degreaser open area, unless necessary to meet OSHA requirements. Ventilation fans should not be used near the degreaser opening.
10. Water should not be visually detectable in solvent exiting the water separator.

Control System B

Control Equipment:

1. Cover (same as in system A).
2. Safety switches.
 - a. Condenser flow switch and thermostat - (shuts off sump heat if condenser coolant is either not circulating or too warm).
 - b. Spray safety switch - (shuts off spray pump if the vapor level drops excessively, about 10 cm (4 in)).
3. Major Control Device:

Either:

 - a. Freeboard ratio greater than or equal to 0.75, and if the degreaser opening is $>1\text{m}^2$ (10 ft^2), the cover must be powered,
 - b. Refrigerated chiller,
 - c. Enclosed design (cover or door opens only when the dry part is actually entering or exiting the degreaser),
 - d. Carbon adsorption system, with ventilation $>15 \text{ m}^3/\text{min per m}^2$ (50 cfm/ ft^2) of air/vapor area (when cover is open), and exhausting <25 ppm solvent averaged over one complete adsorption cycle, or
 - e. Control system, demonstrated to have control efficiency, equivalent to or better than any of the above.
4. Permanent, conspicuous label, summarizing operating procedures #1 to #6.

Operating Requirements:

Same as in System A

CONTROL SYSTEMS FOR CONVEYORIZED DEGREASERS

Control System A

Control Equipment: None

Operating Requirements:

1. Exhaust ventilation should not exceed $20 \text{ m}^3/\text{min}$ per m^2 (65 cfm per ft^2) of degreaser opening, unless necessary to meet OSHA requirements. Work place fans should not be used near the degreaser opening.
2. Minimize carry-out emissions by:
 - a. Racking parts for best drainage.
 - b. Maintaining verticle conveyor speed at $< 3.3 \text{ m/min}$ (11 ft/min).
3. Do not dispose of waste solvent or transfer it to another party such that greater than 20 percent of the waste (by weight) can evaporate into the atmosphere. Store waste solvent only in covered containers.
4. Repair solvent leaks immediately, or shutdown the degreaser.
5. Water should not be visibly detectable in the solvent exiting the water separator.

Control System B

Control Equipment:

1. Major control devices; the degreaser must be controlled by either:
 - a. Refrigerated chiller,
 - b. Carbon adsorption system, with ventilation $\geq 15 \text{ m}^3/\text{min}$ per m^2 (50 cfm/ft^2) of air/vapor area (when down-time covers are open), and exhausting $< 25 \text{ ppm}$ of solvent by volume averaged over a complete adsorption cycle, or
 - c. System demonstrated to have control efficiency equivalent to or better than either of the above.
2. Either a drying tunnel, or another means such as rotating (tumbling) basket, sufficient to prevent cleaned parts from carrying out solvent liquid or vapor.
3. Safety switches
 - a. Condenser flow switch and thermostat - (shuts off sump heat if coolant is either not circulating or too warm).
 - b. Spray safety switch - (shuts off spray pump or conveyor if the vapor level drops excessively, e.g. $> 10 \text{ cm}$ (4 in.)).
 - c. Vapor level control thermostat - (shuts off sump heat when vapor level rises too high).
4. Minimized openings: Entrances and exits should silhouette work loads so that the average clearance (between parts and the edge of the degreaser opening) is either $< 10 \text{ cm}$ (4 in.) or < 10 percent of the width of the opening.
5. Down-time covers: Covers should be provided for closing off the entrance and exit during shutdown hours.

Operating Requirements:

1. to 5. Same as for System A
6. Down-time cover must be placed over entrances and exits of conveyORIZED degreasers immediately after the conveyor and exhaust are shutdown and removed just before they are started up.

APPENDIX C

SUPPLEMENT A: DETERMINATION OF ADEQUATE
CHROMATOGRAPHIC PEAK RESOLUTION

SUPPLEMENT B: PROCEDURE FOR FIELD AUDITING
GC ANALYSIS

SUPPLEMENT A

DETERMINATION OF ADEQUATE CHROMATOGRAPHIC PEAK RESOLUTION

In this method of dealing with resolution, the extent to which one chromatographic peak overlaps another is determined.

For convenience, consider the range of the elution curve of each compound as running from $-2\sigma_s$ to $+2\sigma_s$. This range is used in other resolution criteria, and it contains 95.45 percent of the area of a normal curve. If two peaks are separated by a known distance, b , one can determine the fraction of the area of one curve that lies within the range of the other. The extent to which the elution curve of a contaminant compounds overlaps the curve of a compound that is under analysis is found by integrating the contaminant curve over the limits $b-2\sigma_s$ to $b+2\sigma_s$, where σ_s is the standard deviation of the sample curve.

There are several ways this calculation can be simplified. Overlap can be determined for curves of unit area and then actual areas can be introduced. The desired integration can be resolved into two integrals of the normal distribution function for which there are convenient calculation programs and tables. An example would be Program 15 in Texas Instruments Program Manual ST1, 1975, Texas Instruments Inc., Dallas, Texas 75222.

$$\frac{1}{\sqrt{2\pi} \sigma_c} \int_{b-2\sigma_s}^{b+2\sigma_s} e^{-\frac{t_c^2}{2\sigma_c^2}} dt = \frac{1}{\sqrt{2\pi}} \int_{\frac{b-2\sigma_s}{\sigma_c}}^{\infty} e^{-\frac{x^2}{2}} dx - \frac{1}{\sqrt{2\pi}} \int_{\frac{b+2\sigma_s}{\sigma_c}}^{\infty} e^{-\frac{x^2}{2}} dx.$$

The following calculation steps are required:*

$$1. \quad 2\sigma_s = t_s / \sqrt{2 \ln 2}$$

$$2. \quad \sigma_c = t_c / 2\sqrt{2 \ln 2}$$

$$3. \quad x_1 = (b - 2\sigma_s) / \sigma_c$$

$$4. \quad x_2 = (b + 2\sigma_s) / \sigma_c$$

$$5. \quad Q(x_1) = \frac{1}{\sqrt{2\pi}} \int_{x_1}^{\infty} e^{-\frac{x^2}{2}} dx$$

$$6. \quad Q(x_2) = \frac{1}{\sqrt{2\pi}} \int_{x_2}^{\infty} e^{-\frac{x^2}{2}} dx$$

$$7. \quad I_o = Q(x_1) - Q(x_2).$$

$$8. \quad A_o = I_o A_c / A_s$$

$$9. \quad \% \text{ overlap} = A_o \times 100$$

* (Note: In most instances, $Q(x_2)$ is very small and may be neglected.)

Where:

- A_s = The area of the sample peak of interest determined by electronic integration, or by the formula $A_s = h_s t_s$.
- A_c = The area of the contaminant peak, determined in the same manner as A_s .
- b = The distance on the chromatographic chart that separates the maxima of the two peaks.
- h_s = The peak height of the sample compound of interest, measured from the average value of the baseline to the maximum of the curve.
- t_s = The width of the sample peak of interest at 1/2 of peak height.
- t_c = The width of the contaminant peak at 1/2 of peak height.
- σ_s = The standard deviation of the sample compound of interest elution curve.
- σ_c = The standard deviation of the contaminant elution curve.
- $Q(x_1)$ = The integral of the normal distribution function from x_1 to infinity.
- $Q(x_2)$ = The integral of the normal distribution function from x_2 to infinity.
- I_o = The overlap integral.
- A_o = The area overlap fraction

In judging the suitability of alternate gas chromatographic columns, or the effects of altering chromatographic conditions, one can employ the area overlap as the resolution parameter with a specific maximum permissible value.

The use of Gaussian functions to describe chromatographic elution curves is widespread. However, some elution curves are highly asymmetric. In those cases where the sample peak is followed by a contaminant that has a leading edge that rises sharply but the curve then tails off, it may be possible to define an effective width for t_c as "twice the distance from the leading edge to a perpendicular line through the maxim of the contaminant curve, measured along a perpendicular bisection of that line."

SUPPLEMENT B

PROCEDURE FOR FIELD AUDITING GC ANALYSIS

Responsibilities of audit supervisor and analyst at the source sampling site include the following:

- A. Check that audit cylinders are stored in a safe location both before and after the audit to prevent vandalism of same.
- B. At the beginning and conclusion of the audit, record each cylinder number and cylinder pressure. Never analyze an audit cylinder when the pressure drops below 200 psi.
- C. During the audit, the analyst is to perform a minimum of two consecutive analyses of each audit cylinder gas. The audit must be conducted to coincide with the analysis of source test samples. Normally, it will be conducted immediately after the GC calibration and prior to the sample analyses.
- D. At the end of the audit analyses, the audit supervisor requests the calculated concentrations from the analyst, and then compares the results with the actual audit concentrations. If each measured concentration agrees with the respective actual concentration within ± 10 percent, he then directs the analyst to begin the analysis of source samples. Audit supervisor judgment and/or supervisory policy determines course of action when agreement is not within ± 10 percent. Where a consistent bias in excess of 10 percent is found, it may be possible to proceed with the sample analyses, with a corrective factor to be applied to the results at a later time. However, every attempt should be made to locate the cause of the discrepancy, as it may be misleading. The audit

supervisor is to record each cylinder number, cylinder pressure (at the end of the audit) and all calculated concentrations. The individual being audited must not under any circumstance be told the actual audit concentrations until the calculated concentrations have been submitted to the audit supervisor.

FIELD AUDIT REPORT

PART A - To be filled out by organization supplying audit
cylinders

1. Organization supplying audit sample(s) and shipping address

2. Audit supervisor, organization, and phone number

3. Shipping instructions - Name, Address, Attention

4. Guaranteed arrival date for cylinders _____

5. Planned shipping date for cylinders _____

6. Details on audit cylinders from last analysis

	Low Conc.	High Conc.
a. Date of last analysis	_____	_____
b. Cylinder number	_____	_____
c. Cylinder pressure, PSI	_____	_____
d. Audit gas(es)/balance gas	_____	_____
e. Audit gas(es) ppm	_____	_____
f. Cylinder construction	_____	_____

PART B - To be filled out by audit supervisor

1. Process sampled _____

2. Location of audit _____

3. Name of individual audited _____
4. Audit date _____
5. Audit results

	Low Conc. Cylinder	High Conc. Cylinder
a. Cylinder number	_____	_____
b. Cylinder pressure before audit, psi	_____	_____
c. Cylinder pressure after audit, psi	_____	_____
d. Measured concentration, ppm		
Injection #1*	_____	_____
Injection #2*	_____	_____
Average *	_____	_____
e. Actual audit concentration, ppm	_____	_____

(Part A, 6e)

* Results of two consecutive injections which meet the sample analysis criteria of the test method.

f. Audit accuracy*

Low Conc. Cylinder

High Conc. Cylinder

$$\text{* Percent accuracy} = \frac{\text{Measured Conc.} - \text{Actual Conc.}}{\text{Actual Conc.}} \times 100$$

g. Problems detected (if any) _____
